AUGUST 1971

rsc

RAILWAY SYSTEM CONTROLS

Radio tests made for slave locomotives

CF 73 G 55
R R TAYLOR
40 WEST ROAD
LOMBARD ILL 60148

RACO® XRL GRADE CROSSING RELAY LOGIC UNITS

RACO MR-10 RELAYS

MR-10 Relays have silver impregnated carbon front contacts, positive, non magnetic armature stop, gravity and redundant spring armature return, wide contact opening, complete isolation of contacts and plug-in feature.

RACO SSF-10 FLASHER

The RACO solid state flasher SSF-10 uses silicon transistors for maximum thermal stability, and has current capacity of 20 amperes. Design permits tandem and synchronous operations for multiple units where current needs are in excess of 20 amps. No moving parts or contact to arc and burn.

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Circle 1 on reader service card

AUGUST 1971

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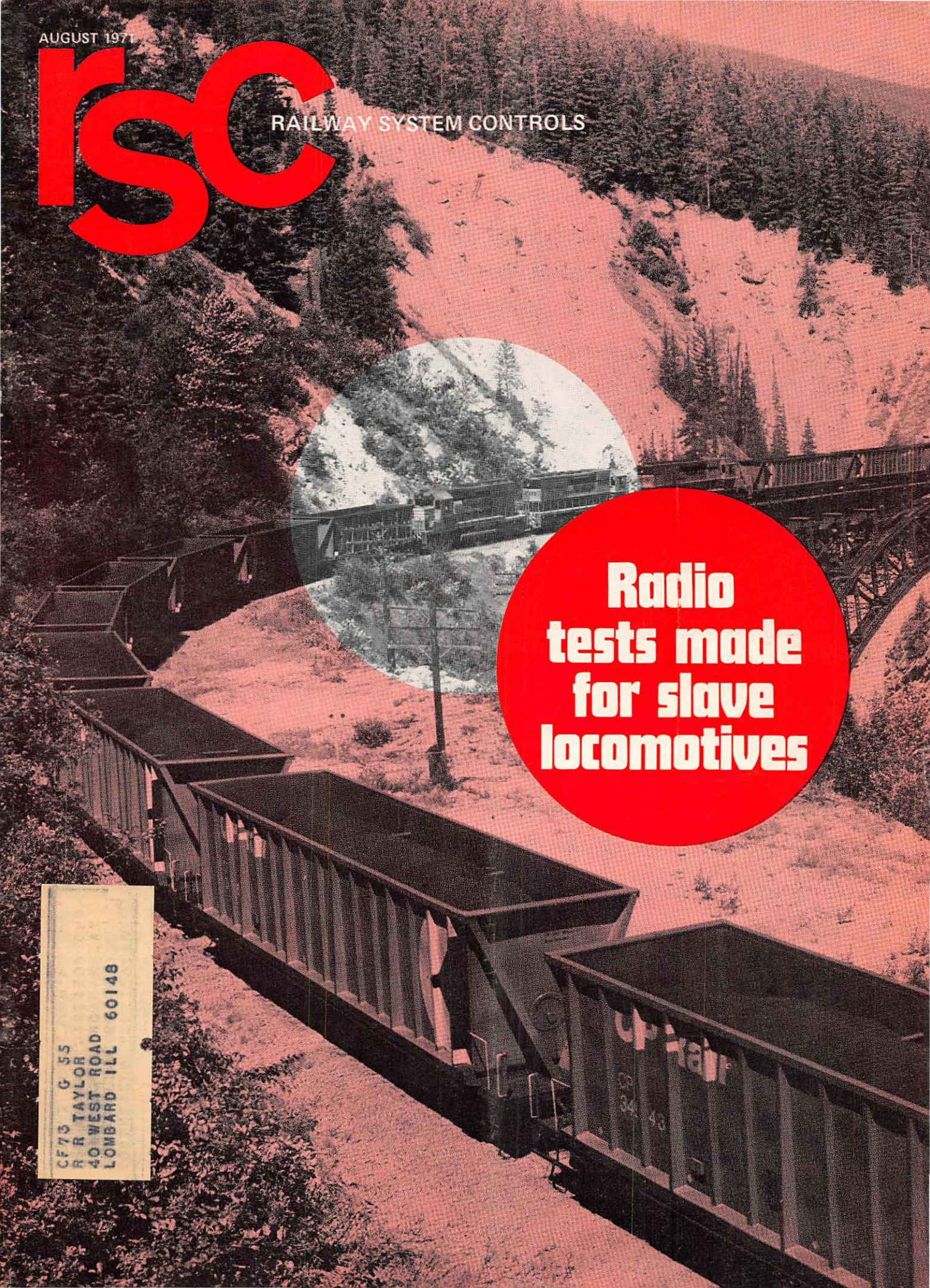

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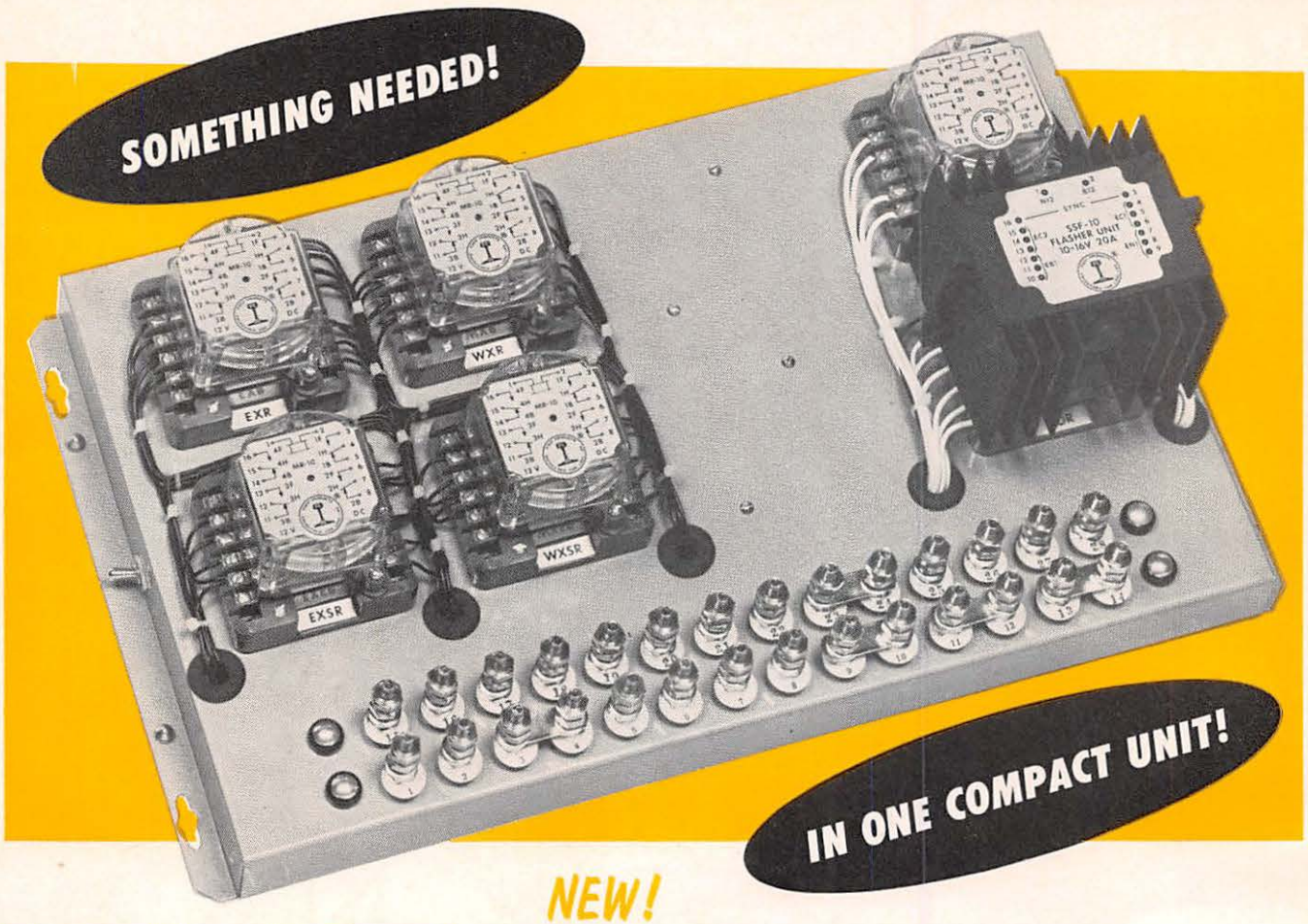

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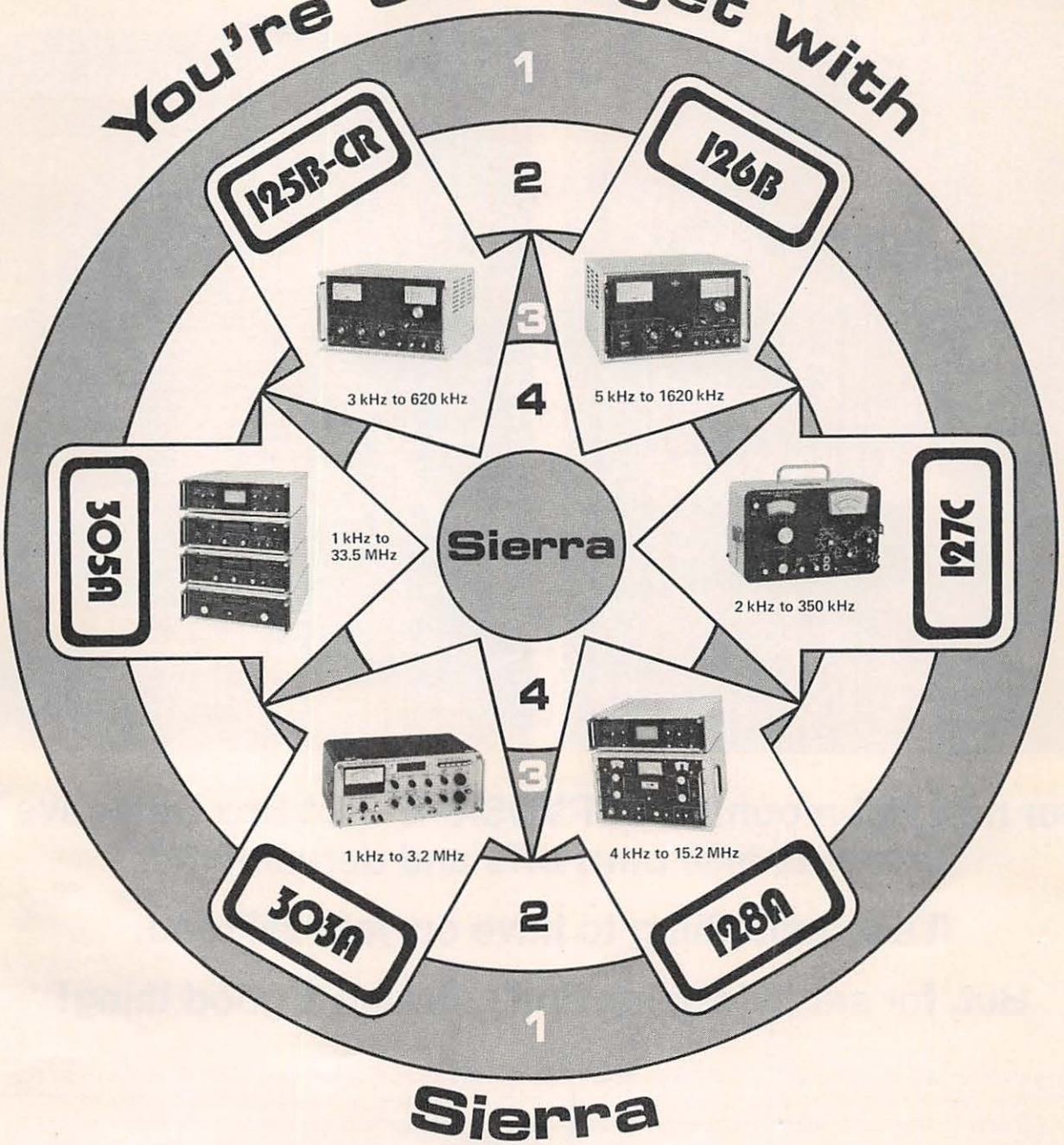

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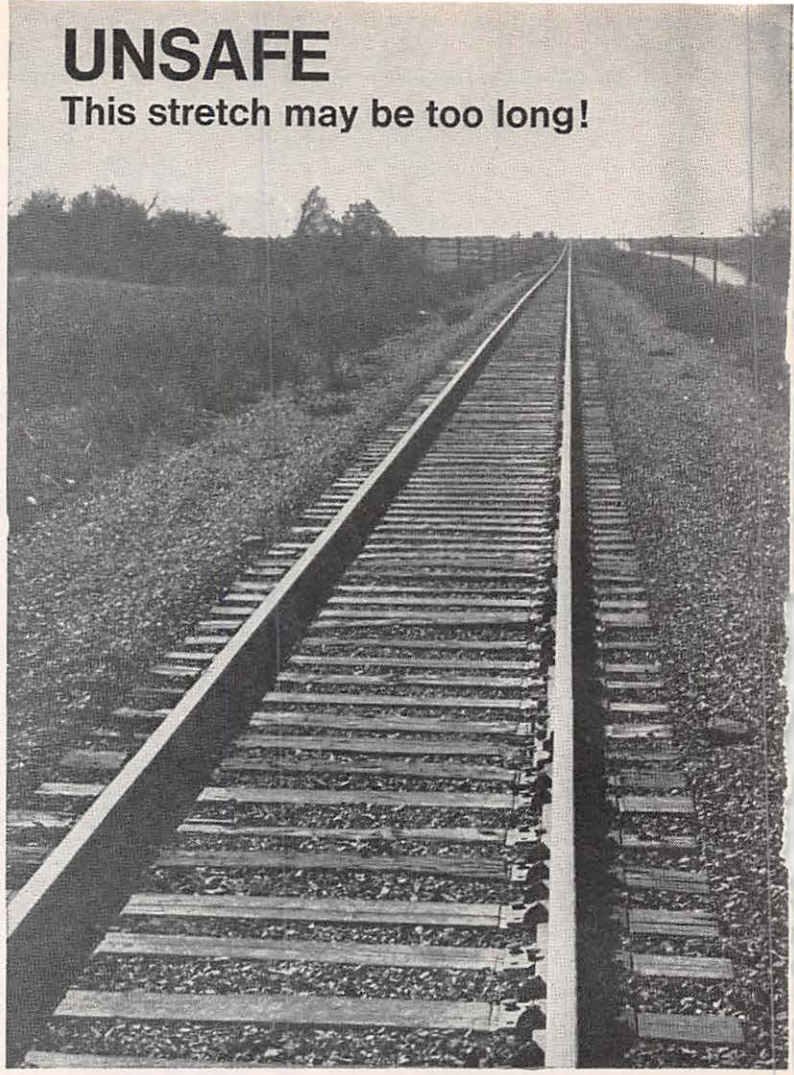


Our new rail-mounted SERVOSAFE® Hot Box Detective™ prevents axle burn-offs and derailments.

It's a good thing to have on your railroad.

But, for safety's sake, don't stretch a good thing!

Do you have long stretches of track without SERVOSAFE protection?

Recent studies have revealed that such factors as heavier car loadings, faster train speeds and greater accelerations have combined to increase the incidence of overheated journal boxes. This has prompted many railroads to review their spacing of hot box detectors. Up to now, the average spacing has been 25 to 30 miles apart along line-of-road. Under today's conditions, however, a hot box can develop in less than 25 miles and cause a derailment *between* detectors.

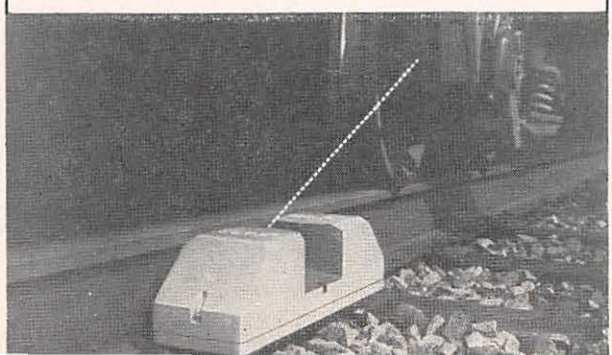
One solution becomes self-evident: closer spacing of hot box detectors for more protection. A SERVOSAFE system will not prevent a hot box—but it will detect, locate and warn of a hot box before the condition worsens into a dangerous, costly axle burn-off and derailment!

Will it cost you more to get this additional SERVOSAFE protection? Not really. Here are some reasons why not:

Our new Model 8808 SERVOSAFE system features patented rail-mounted scanners and solid state electronic data processing for the fastest, most precise detection of hot boxes. It allows remedial action to be taken *before* a failure occurs, and helps cut down the high costs of major salvage or replacement. The cost of installation and maintenance is appreciably reduced by eliminating the need for concrete foundations, special ties and expensive roadbed preparation. The rail-mounted scanner can be easily removed for maintenance or relocation. Finally, compare the cost of a SERVOSAFE with the $200,000 involved in just one derailment that could be prevented.

That's why most prudent, progressive railroad managements agree when we say, "More SERVOSAFE protection isn't costly—*lack of it is!*"

Model 8808 SERVOSAFE Hot Box Detective Rail-mounted scanner "looks" at journal bearing behind truck frame with a vertical, close-in target scan for greater uniformity and accuracy. Scanner is securely clamped to the rail (no drilling required). Accuracy is not affected by rail pumping, running or lateral movement.



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AUGUST 1971 VOL. 2 NO. 8

RSC RAILWAY SYSTEM CONTROLS

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Editorial Office
29 E. Madison St., Chicago, Ill. 60602

Robert W. McKnight, Editor

Mrs. Grace Rempert, Editorial Assistant

Executive Office
350 Broadway, New York, N.Y. 10013

Robert G. Lewis, Publisher

Fred B. Hecht, Production Manager

Maurice H. Mates, Art Director

John E. Rogers, Director of Circulation

Constance Nicolai,
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News Briefs

N&W saves $500,000 by deleting reports

Total estimated savings created by the elimination or reduction in reports and forms come to $520,000 on the Norfolk & Western.

Five months ago, N&W officials assembled in a hotel ballroom for a two-day session headed by president John P. Fishwick to eliminate unnecessary paper work. During 1969, the company had spent $2.5 million for paper—half of what it had expended for new rail used that year over its 8,000-mile railroad.

Dubbed "Operations Wastebasket" the session was attended by all department heads with the admonition by Fishwick:

"I don't want anyone to leave here until we get the job done. The railroad will run even if we have to stay in this room all day."

Results of "Operation Wastebasket" are as follows:

—Savings of $400,000, representing 78,485 manhours required to prepare reports.

—Savings of $69,000 annually in paper consumed by computerized reports.

—Savings of $40,000 annually in computer printing capacity.

—Savings of $10,000 annually in paper used for manually prepared reports.

—Total estimated savings of $520,000, enough to purchase two locomotives or 35 new freight cars.

Of 3,624 reports prepared before "Operation Wastebasket," 829 were eliminated and an additional 209 were reduced in size or quantity of distribution.

Undisputed leader in the savings campaign was the office of auditor of station accounts, headed by Raymond R. Mask. When "Operation Wastebasket" began, Mask's office was preparing reports totaling 5,397,800 pages annually. By mid-April, his office has reduced this to 2,561,000 pages and Mask said further reductions were under way.

Other leaders in the campaign were the company's operating divisions and terminals, which eliminated 528 of 1,252 reports previously prepared and reduced another 20.

The transportation department eliminated 34 of 77; engineering dropped 21 of 51; mechandise traffic stopped 16 of 63; budget and management information, eliminated 19 of 44; personnel dropped 25 of 47 and material management discarded 55 of 90.

Fishwick said he was pleased with the response and results of the program, but added that the campaign will continue.

Dr. Paul M. Zeis, N&W director of research, summed up "Operation Wastebasket" this way:

"Over and above the tangible savings is the fact that administrators are now paying more careful attention to the reports generated or used by their departments with substantial indirect benefits accruing to the company."

UMTA awards last AVM contract for $263,000

The fourth and final contract in a program to develop automatic vehicle monitoring systems has been awarded to Sierra Research Corp., Buffalo, N.Y., by the Urban Mass Transportation Administration in the amount of $263,000. Sierra will carry out tests of a technique known as "trilateration" to determine its effectiveness in urban vehicle tracking.

The trilateration technique locates a vehicle by measuring the time required for a radio signal to travel from the vehicle to each of several receiving stations located around a city. A computer can instantly convert these time measurements into an electronic display on a map locator.

Rock Island and BofRS agree on training

The Brotherhood of Railroad Signalmen and Chicago, Rock Island & Pacific have signed an agreement establishing a training program for signal employees on that railroad.

The agreement provides for classes to be located in the signal repair shop at Silvis, Ill. The classroom has been established and C. R. Storck was appointed signal training supervisor in charge of the classroom instructions. The first class began in mid-March, 1970.

The program is designed to have six employees in class for two weeks, then they return to their regular job. The students are given manuals for home study and time will be given for this purpose. Every student will complete five two-week sessions over a two-year period. They must receive at least a 70% grade to pass an examination on both class work and home study before proceeding to the next class. If they fail to pass they will be re-examined within 30 days on the portion they failed; failure to pass the re-examination will result in the employee being released from service.

The training program is compulsory for assistants. Employees with first class seniority and less than four years of service are attending classes at this time—other employees are selected in seniority order.

Assistants may be promoted to the signalman or maintainer class under the agreement rules but must complete the training program.

While attending the classes at Silvis, students are paid all expenses and their regular rate of pay.

When employes are notified to attend classes they are advised what form of transportation to be used to and from classes. If company transportation is not available and commercial transportation used, the student is reimbursed the cost thereof. If he is authorized to use his automobile, he is paid nine cents a mile to and from classes.

The five training manuals used in the home study course were originally designed by the Canadian National. The CN permitted the Rock Island to reproduce the books.

FRA gives conditional OK for relay testing

In a decision by hearing examiner, Robet R. Boyd, Penn Central Transportation Co. has been given relief from requirement of 49 C.F.R. 236.-106 to the extent that it not be required to test miniature relays in modular-type interlockings at least once every two years. It apparently is agreeable to checking the relays every five years.

An abstract from the report on RS&I application No. 171 follows:

In the application, applicant (Penn Central) gives the following as a supporting statement:

The failure of a relay to respond to the position intended will not result in an unsafe condition.

The fundamental reason for requiring tests of the electromagnetic characteristics of relays at least once every two years is to prevent improper working of the installation or system when a relay fails to respond as intended. This protection is provided by

(Please turn to page 17)

Why YOU should try the Frequency-Shift Overlay Track Circuit.

It's an entirely new concept in overlay track circuits, and it really gets results. New, super-selective tuned circuits and new receiver techniques (patent pending) pull a strong, clean signal out of noise and interference conditions once thought impossible. Where conditions are worse than bad, you can beef up the transmitter with an optional power amplifier – and slam the signal through with a hefty four watts. Power line interference is no longer a problem. All fifteen frequency channels are selected to be clear of harmonics of any currently-used power frequencies, and are mutually compatible with one another. Frequency determining elements plug in. A transmitter or receiver can be changed from one channel to another in minutes.

Centralized equipment installations are easy with FSO. The transmitter can be 3000 feet from the track connection, and the receiver can be 6000 feet from the track connection. At low frequencies, track circuits can be as long as 6000 feet.

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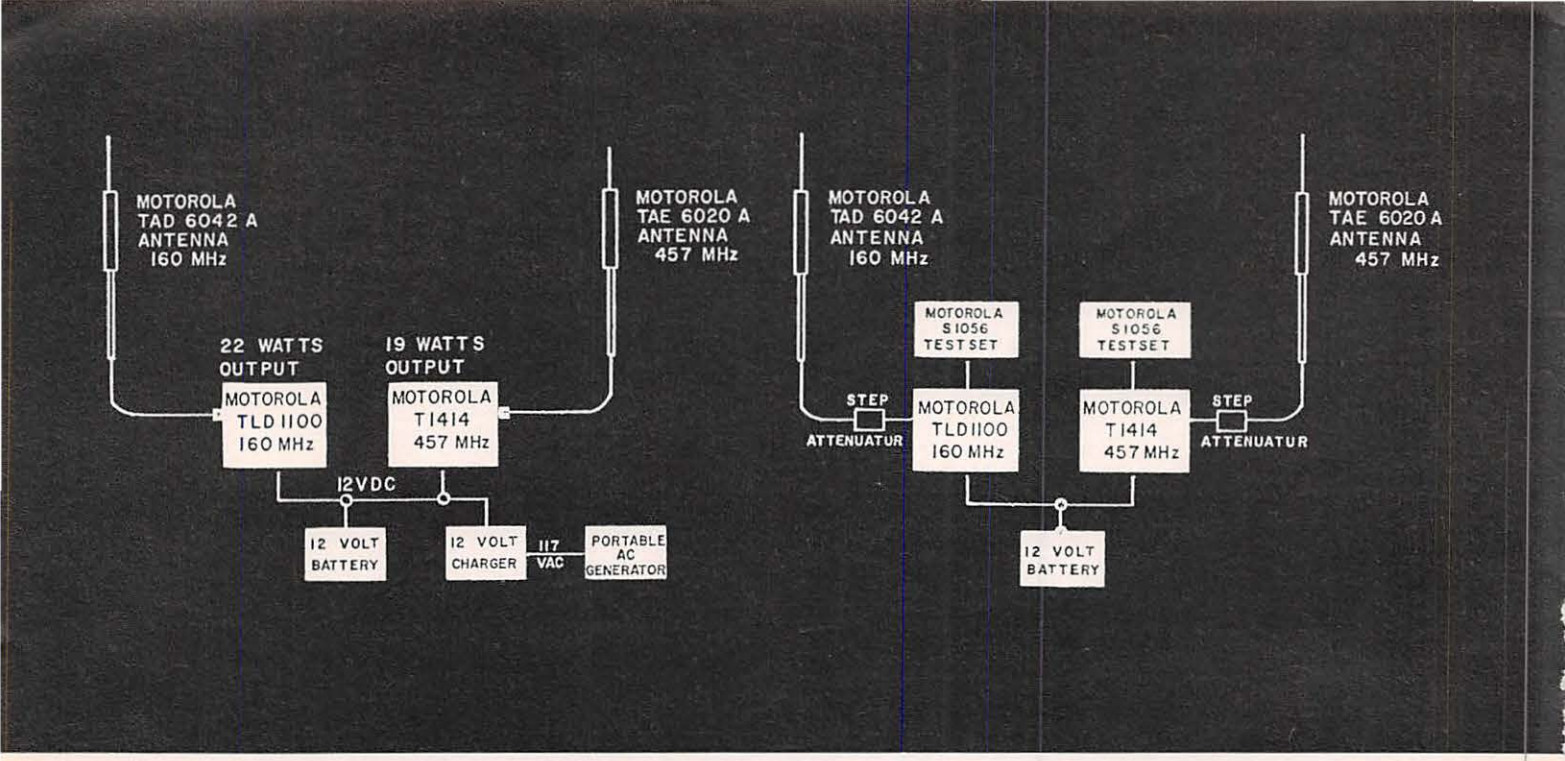


FIGURE A: Equipment arrangements for transmitter car (left) and receiver car (right) for radio tests.

VHF radio coverage tested

Radio propagation tests carried out at 160 and 457 MHz in North Carolina along Southern Railway.

With the increasing use of unit trains, and longer freight trains, remotely-controlled helper or slave locomotives placed toward the rear of these long trains has become quite commonplace. Controls from the lead unit, and indication or status responses from the slave unit are sent between units using VHF radio. Continuity of radio service is essential for satisfactory slave locomotive operation. Several railroads have made radio propagation tests to determine the extent of radio coverage along lines where such slave locomotive operation takes place.

Results of a series of tests made in the 160-450 MHz range as related to remote controlled locomotive systems in irregular terrain were reported at the 1970 annual meeting of the Communications & Signal Section, AAR. Also reported were communications considerations for remote control of locomotives using radio links. Permission to present the report has been granted by the C&S Section. Our thanks to John L. McNabb, engineer, communications and signals, C&S Section, and Committee B-Radio and Microwave Systems, which prepared the report.

The purpose of these tests was to gather data to use in determining what difference, if any, exists in radio propagation at frequencies of 160 MHz and 450 MHz over irregular terrain at antenna heights corresponding to that used in remote controlled locomotive service and at various lead-remote separations of 0.5 miles to 5.0 miles. The tests were conducted during the week of December 8-12, between Old Fort and Ridgecrest, N.C.

The equipment set-up shown on Fig. A was installed on rail motor cars with the feed point of the antennas 15 ft above the rail, to simulate locomotive antenna heights and to place the antennas in the same relation to obstructions as would be encountered in train operation.

Difficulty in obtaining delivery of the test antennas, and weather conditions, restricted test time. Therefore, the scheduled tests were reduced to those felt essential to obtaining basic data.

The 13.3 mile section of railroad between Old Fort and Ridgecrest was selected as it provided the best balance between representative terrain, access and availability of track usage between trains. The "airline" distance between these two points is approximately 6.5 miles.

The first series of tests were conducted with the transmitter car located at Old Fort Depot and Mill Road Crossing, approximately 0.3 miles west of Old Fort Depot. The receiver car was then operated westward along the track to various locations, selected to give data that would indicate radio propagation differences at the test frequencies

MANAGEMENT INFORMATION

Radio propagation tests have been carried out to determine continuity of coverage in various terrains. Successful use of slave locomotive units in handling long trains depends upon continuous radio coverage because radio is the communications link between lead unit and the slave unit.

Sources for information include:

Bullington, *Proceedings of the Institute of Radio Engineers*, Jan. 1950.

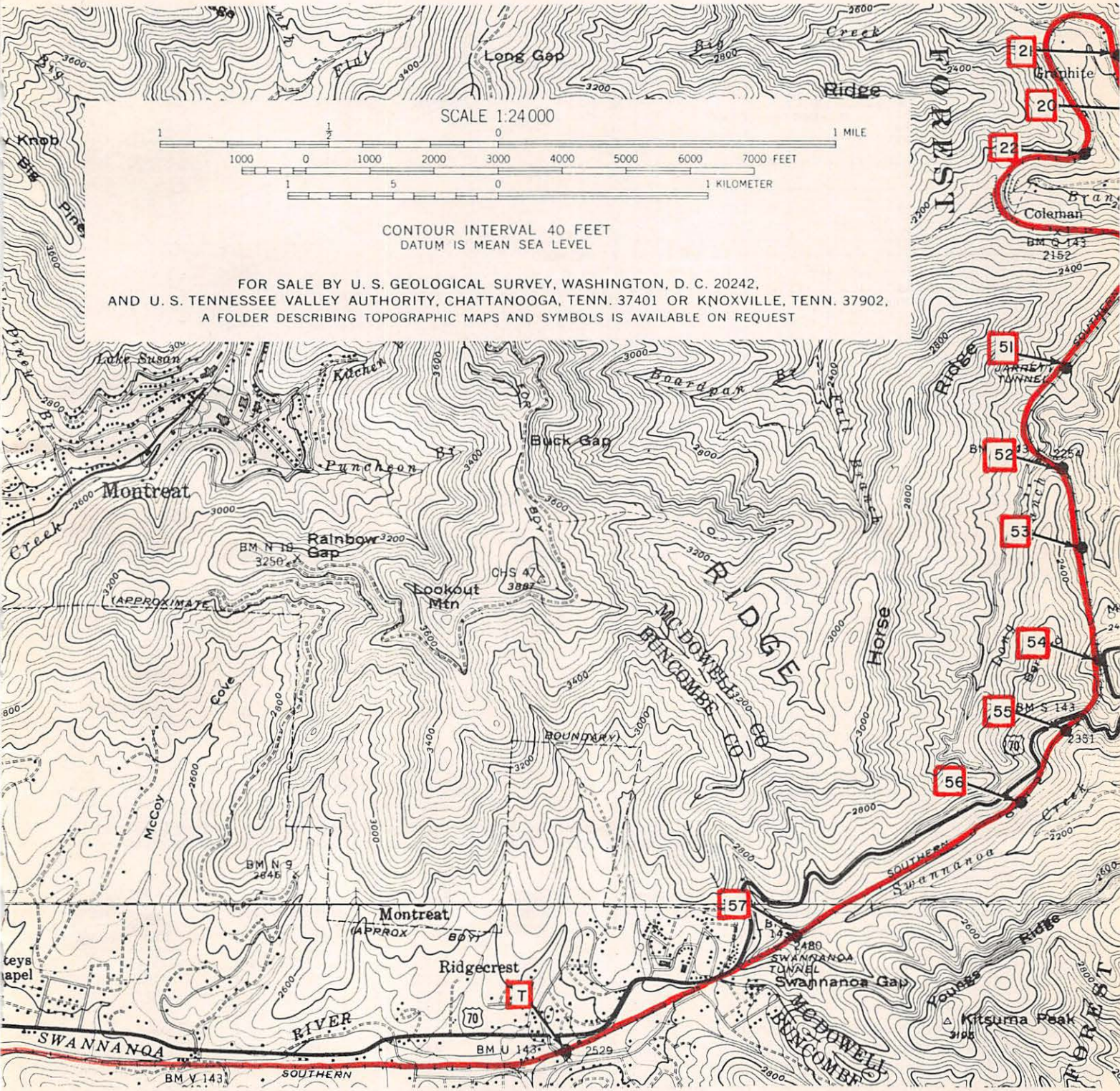
Egli, *Proceedings of the Institute of Radio Engineers*, Oct. 1957.

Report of VHF vs. UHF propagation tests in 450 MHz band for end-to-end radio communications, Canadian National Telecommunications, Apr. 29, 1969.

Report of VHF vs. UHF field strength tests conducted by WABCO's Signal and Communications Division on the Louisville & Nashville between DeCoursey and Hazard, Ky., during week of June 9, 1969.

Engineering report of slave locomotive tests performed on Santa Fe, Sept. 10, 1969.

Comparative 160-450 MHz propagation tests as related to remote controlled locomotive systems in irregular terrain, performed on the Southern, Dec. 8-12, 1969.



MONTREAT AND BLACK MOUNTAIN quadrangles where radio tests were conducted.

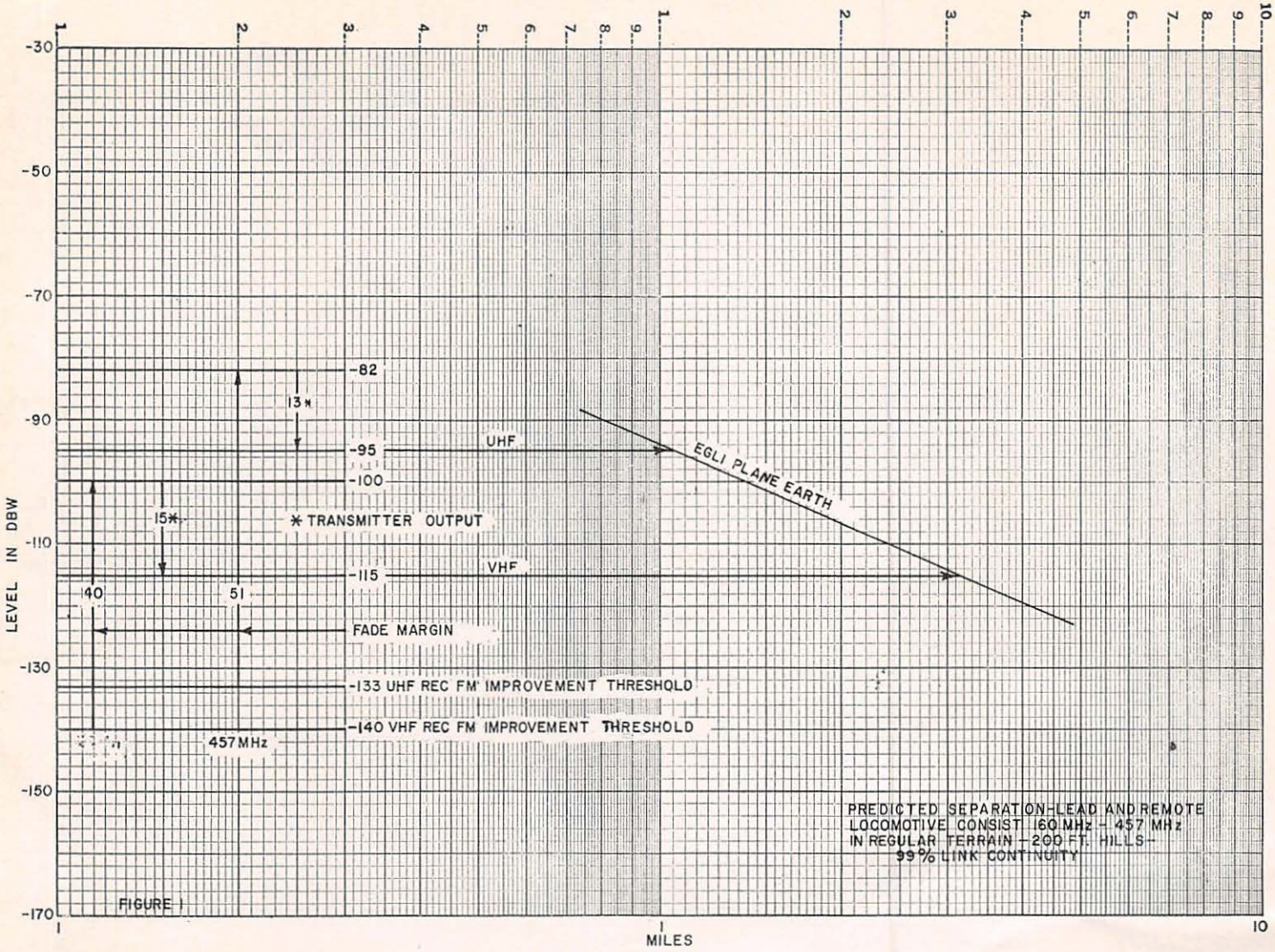


FIGURE 1: Comparison of VHF and UHF systems using equipment presently begin marketed.

and to locate, if possible, areas of low signal strength that would cause "LOSS OF CONTINUITY" to remote controlled locomotive operation. At each test location, with the transmitters keyed for 1.5 to 2 minutes, six to ten readings were taken at 2- to 3-foot increments to establish a median signal level for that point.

The second series of tests were conducted with the transmitter car located at Ridgecrest. The receiver car was operated westward, starting at the west end of Coleman Siding (approximately MP 119.5), taking various readings to establish a median signal level for each point as described above.

The data obtained, shown on Figs. 2 and 3, has been reduced to show median signal levels at each frequency for each point, indicating airline distance and track mileage.

It would appear from the test results that the overall test transmitter-feedline-antenna combinations provided about equal effective radiated power of +13 dbw at 160 MHz and 457 MHz. Therefore, no correction factor is necessary to the received carrier powers for comparative purposes.

Location Receiver Car	Track Miles	Airline Miles	160 MHz Median Signal		457 MHz Median Signal	
			dbw	uV	dbw	uV
2	0.6	0.45	— 88.0	300	— 94.0	137
3	0.8	0.50	— 96.0	110	—102.0	55
4	1.0	0.55	—101.0	63	—104.0	47
5	1.1	0.75	— 95.0	126	—113.0	16
6	1.2	0.80	—118.0	8.5	—124.0	4.5
7	1.4	0.90	—114.0	14.0	—125.0	4.0
8	1.6	1.10	—121.0	6.3	—126.0	3.5
9	1.9	1.45	—121.0	6.3	—131.0	2.0
10	2.1	1.60	—127.0	3.1	—137.0	1.0
11	2.5	2.00	—124.0	4.5	—132.0	1.75
12	3.0	2.50	—127.0	3.0	—134.0	1.50
13	3.4	2.90	—131.0	2.0	—134.0	1.50

FIGURE 2: Tests at Old Fort, westward, with transmitters at location 1. Beyond 13, added track mileage did not cause appreciable increase in transmitter-receiver separation.

Location Receiver Car	Track Miles	Airline Miles	160 MHz Median Signal		457 MHz Median Signal	
			dbw	uV	dbw	uV
57	0.75	0.75	—103.0	51.0	—111.0	20.0
56	1.55	1.55	—115.0	13.0	—116.0	12.0
55	1.85	1.80	—121.0	6.4	—132.0	1.75
54	2.0	1.95	—135.0	1.5		*
53	2.35	2.15	—129.0	2.4		*
52	2.70	2.30	—135.0	1.25		*
51	3.10	2.50	—128.0	2.8	—138.0	1.0

FIGURE 3: Tests at Ridgecrest eastward; transmitters at Ridgecrest depot. *Signal too low for reliable readings.

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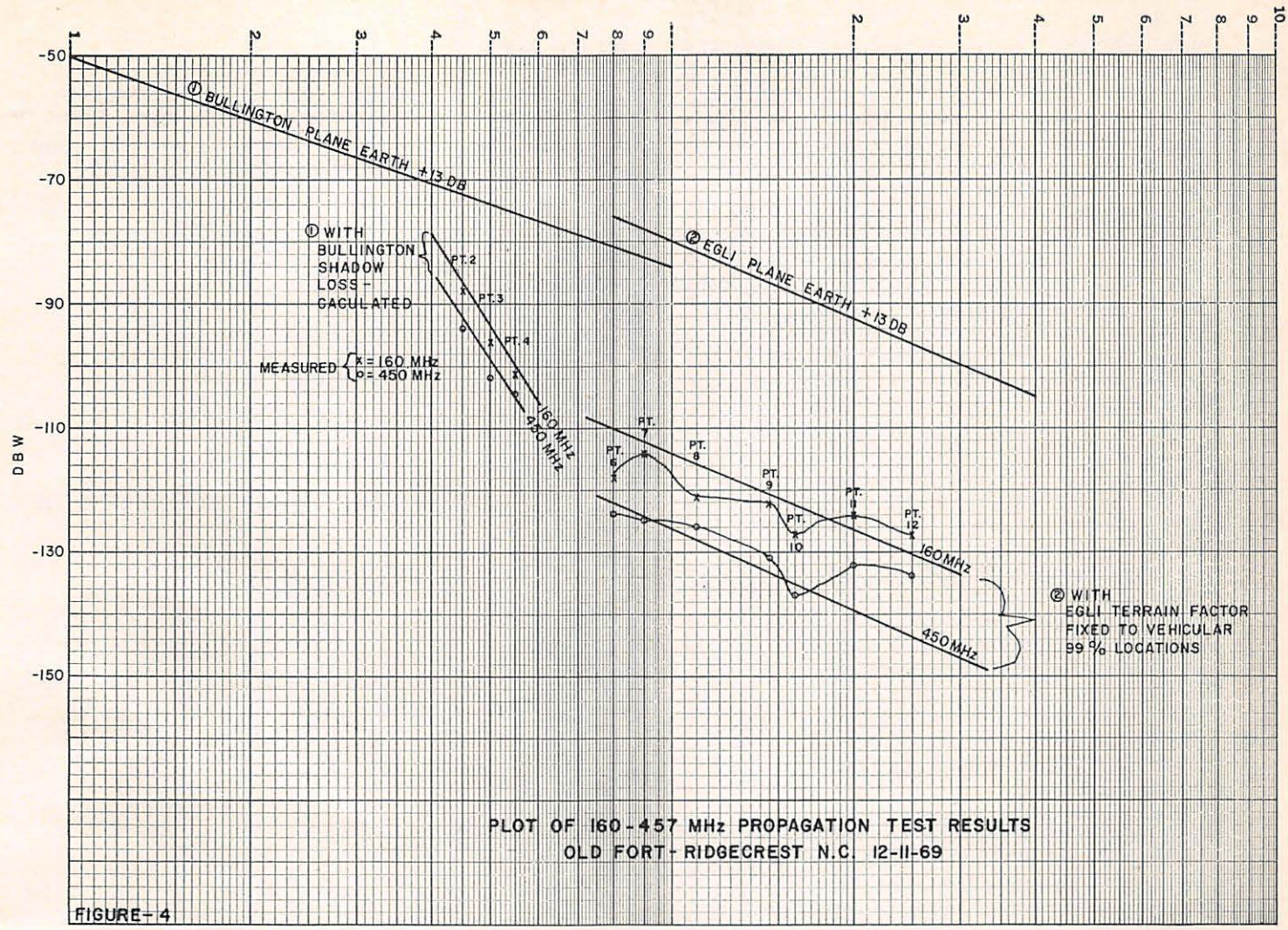


FIGURE 4: Results of tests in hilly terrain and effect of passing through a tunnel.

The median signal levels measured at Locations 2, 3 and 4 were made with a single hill as an obsrtuction. The first mile of track curved around this hill, keeping the transmitter-receiver separation about the same—approximately 0.5 miles. These levels, considering the usual 5 to 7 db measured below calculated, correspond closely to Bullington plane earth plus shadow losses.

There is a marked increase in signal level on both frequencies at Location 5, where the receiver car was stopped on a bridge just before entering a tunnel with sharp rises in terrain ahead and away from the direction of the transmitter, thus providing a higher effective antenna height to the receiver signal, and an increase of reflected signal.

The effect of passing through the tunnel, thus providing a second obstruction, is shown by a marked drop in signal levels at Location 6. Levels at Location 6 through 12 are generally bracketed within the values predicted by Egli for plane earth plus received power terrain factor for fixed to vehicular at 99 percent locations. The test points selected were those felt would constitute a difficult area to cover; therefore, it is assumed they represented 99 percent locations. The median signal difference between 160 MHz and 457 MHz is 8 db. However, the path loss versus distance measured is not as steep as predicted. This is attributed to increasing rise in track altitude of the receivar car as it proceeded away from the transmitter car, and to the fact Egli's predictions were based on 500-ft hills while those in the test area are approximately 280 ft high. (See Fig. 4.)

Although there is a very short tunnel between Locations 5 and 6, the railroad runs through a winding canyon from which signal is apparently received by direct propagation plus obstruction losses and multiple reflections, as most locations showed high variations in signal strength in short sectors.

Locations 51 through 57 included five tunnels which after the first (Swannanoa Tunnel), for the most part, eliminated multi-reflected signal paths, as the signal strength variations were relatively low. One exception was at Location 56, where the terrain through which the second tunnel passed formed a backdrop for reflecting signals. It would appear the signal strength basically follows Bullington plane earth plus shadow loss. However, topographical maps for the area do not provide sufficient accurate information to make this calculation practical.

The growth in the number of systems now in operation indicates the successful results industry has obtained from the use of remote controlled locomotives. However, the placement of a portion of the locomotive consist at some point back in the train and controlling it from the remaining portion of the locomotive consists located on the front end of the train, requires a control system that provides an extremely high degree of reliability. While the "back-to-back" reliability of the equipment is generally very high, overall operational system reliability depends upon a radio communications link whose performance is affected by many propagation factors, such as frequency, terrain, distance, etc. While these factors that affect radio propagation reliability are well known in some areas of communication, their degree of effect on mobile-to-mobile transmission of high security digital data messages as used in re-

mote controlled locomotive systems should be investigated.

To provide the necessary degree of integrity and safety of train operation, a message coding with error detection scheme must be utilized that will prevent unwanted reaction by the remote controlled locomotive consist or incorrect indication of its status at the controlling location on the front end of the train. These "high security" type coding systems result in the rejection of the entire multi-bit message upon the detection of single or many types of multiple bit errors. Therefore, bit error rates must be kept low.

Experience has proved that the coding systems used do provide the necessary degree of protection against improper reaction by the remote controlled locomotive system. However, the problem now becomes to provide a communications link that will not introduce bit errors above that required to permit sufficient data messages to be relayed between the locomotive consists to retain system control. An acceptable message must be sent to the remote units, as well as an acceptable replay message received at the lead unit, to constitute retention of total communications link integrity.

Lack of acceptable messages to the lead unit for 45 seconds will result in "LOSS OF CONTINUITY" indication, and lack of an acceptable message at the remote unit within any 45-second period will return the remote locomotive consist to "IDLE" condition unless some prior interceding action such as "OVER RIDE" has been initiated.

Bit errors on communications link circuits are generally caused by insufficient signal-to-noise ratios at the receiver input. The signal-to-noise ratio is mainly affected by receiver input carrier-to-noise ratio and interfering signals, with the former being the most prevalent cause. As the actual signal-to-noise ratio required to produce an acceptable bit error rate depends upon many factors, a figure of 20 db signal-to-noise ratio is considered a reasonably obtainable value that provides a very low bit error rate and corresponds to the lower usable sensitivity point of the types of communications receivers employed in remote control locomotive service. Typically, these sensitivity values are 0.75 uv for 160 MHz receivers and 1.75 uv for 457 MHz receivers. Noise from signal interference can come from other radio systems in the immediate area. This noise source is particularly troublesome when utilizing radio frequencies in the 160 MHz railroad band for remote control of locomotives where radio voice communication systems are installed and used simultaneously on these same locomotives. Due to the lack of ample frequency separa-

Transmitter Car at Old Fort Depot

Receiver Car Location	Track Miles	Airline Miles	160 MHz (21W) Median Signal			457 MHz (19W) Median Signal		
			MV	MV	DBW	MV	MV	DBW
1	0.4	0.3	400			346		
			200	550	— 82	188	173	— 92
			800			110		
			700			158		
Transmitter Car at Location 1								
2	0.6	0.45	300			220		
			500			126		
			300	300	— 88	346	137	— 94
			110			47		
			300			158		
			300			79		
3	0.8	0.5	110			63		
			300			47		
			110	110	— 96	79	55	—102
			100			19		
			200			63		
			50			47		
4	1.0	0.55	75			47		
			95			32		
			47			64		
			47	63	—101	56	47	—104
			95			24		
			47			32		
			63			64		
5	1.1	0.75	126			32		
			126			20		
			158			12		
			95			20		
			158			16		
			126	126	— 95	12	16	—113
			126			16		
			95			16		
			63			25		
			95			—		
6	1.2	0.80	20.0			5.0		
			15.0			8.0		
			5.0			4.0		
			7.5	8.5	—118	4.0	4.5	—124
			6.3			1.2		
			9.5			4.0		
7	1.4	0.90	25.0			8.0		
			12.0			4.0		
			9.5			4.0		
			16.0	14	—114	5.0	4	—125
			3.1			4.0		
			16.0			4.0		
8	1.6	1.1	2.4			4.0		
			6.3			2.0		
			9.5			5.0		
			9.5	6.3	—121	2.0	3.5	—126
			3.2			3.5		
			2.2			2.5		
			3.5			4.0		
9	1.9	1.45	6.3			1.5		
			4.7			2.0		
			3.2			2.5		
			9.5	6.3	—121	1.5	2	—131
			6.3			3.5		
			6.3			2.0		

RADIO PROPAGATION TESTS conducted from Old Fort, N.C., westward.

Transmitter Car at Location 1

Receiver Car Location	Track Miles	Airline Miles	160 MHz (21W) Median Signal MV	160 MHz (21W) Median Signal MV	160 MHz (21W) Median Signal DBW	457 MHz (19W) Median Signal MV	457 MHz (19W) Median Signal MV	457 MHz (19W) Median Signal DBW
10	2.1	1.6	3.2			1.0		
			3.5			0.0		
			2.4			1.0		
			3.5			1.0		
			0.75	3.1	—127	0.0	1	—137
			3.00			2.0		
			5.00			1.5		
			3.00			1.5		
11	2.5	2.0	3.0			2.0		
			9.5			0.0		
			4.0			2.0		
			3.0			2.0		
			9.5	4.5	—124	2.5	1.75	—132
			4.0			1.5		
			5.0			1.5		
			7.0			0.6		
12	3.0	2.5	3.0			1.5		
			0.5			1.5		
			2.0			2.0		
			7.0			1.0		
			0.5	3.0	—127	1.5	1.5	—134
			0.75			0.0		
			3.00			2.0		
			4.00			0.6		
13	3.4	2.9	2.00			1.5		
			0.25			1.5		
			2.00			0.6		
			4.00			2.0		
			0.75	2.0	—134	2.5	1.5	—134
			4.00			0.6		
			2.00			1.5		
			3.00			1.0		
14	3.7	3.2	5.0			0.6		
			3.0			2.0		
			3.0			2.0		
			7.0			1.5		
			7.0	4.0	—125	2.0	2.0	—131
			4.0			2.0		
			4.0			0.0		
			3.0			2.0		
			4.0			2.0		
			4.0			2.0		
15	4.2	3.2	2.0			0.6		
			4.0			0.0		
			1.1			1.0		
			1.5			0.0		
			1.0	1.3	—135	1.0	0.3	—145
			3.0			2.0		
			0.5			0.0		
			1.0			0.0		
			1.1			0.0		
			1.5			0.6		
16	4.45	3.5	1.1			0.0		
			0.75			1.0		
			1.50			1.5		
			1.10			0.6		
			0.50			1.0		
			1.10	1.1	—136	0.0	0.6	—142
			2.00			0.6		
			0.75			0.6		
			1.10			0.0		
			2.00			2.0		
			2.00			0.0		

BEYOND THIS POINT—457 MHz signals below 0.6 MV
160 MHz signals averaged 1-2 MV
For 4.3 miles airline, 5.4 miles track

tion within the railroad radio band, it is difficult to provide sufficient system separation isolation.

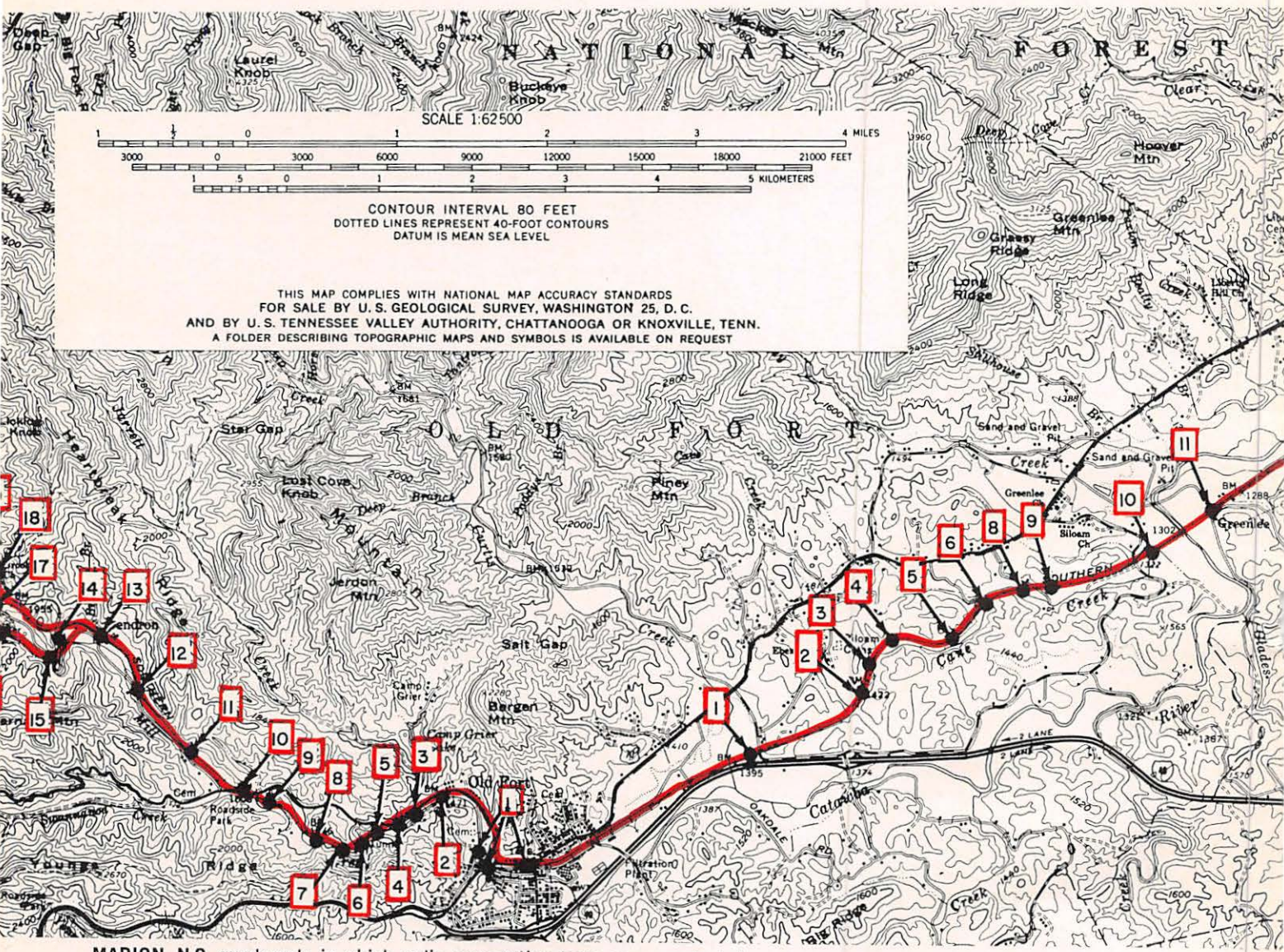
Considering the input carrier-to-noise ratio, the problem then becomes that of keeping the receiver carrier input above the minimum value for a sufficient percentage of the time to retain normal control of the remote control system. General usage of remote controlled locomotive systems is that of handling long, high tonnage trains over a sector that usually includes highly irregular terrain with moderate to severe ascending and descending grades. This type of terrain places the most severe impediments upon system propagation reliability, with losses from intervening hills, cuts, tunnels and multipathing.

It now becomes apparent, as in other radio systems, that one must include some degree of "fade margin" in the remote locomotive control system. How much depends on many factors; with restricted antenna heights and fixed equipment gains, the only controllable variable remaining is transmitter-receiver separation, that is, how far back in the train consist the remote locomotive consist can be placed, and still reliably communicate with the lead or controlling locomotive consist over the trackage it will be operated.

In most high reliability radio systems such as microwave point-to-point systems, fade margins compensate for time fading caused by atmospheric conditions while operating under fixed terrain conditions. In short range mobile-to-mobile systems, atmospheric conditions cause insignificant variations; therefore, the fade margins for remote control locomotive systems compensate for variations in terrain conditions. As in any high reliability system, one must select a level of performance and use empirical data to arrive at a fade margin. Fortunately, in remote control locomotive systems there are some offsetting conditions. For instance, long trains are generally operated over flat terrain where propagation problems are minimum. Also, moderately long trains are operated over irregular terrain where, due to curves, lead-to-remote locomotive consist separation is reduced in the areas where propagation problems are the most difficult.

In view of the numerous variables in terrain, both natural and man-made, as well as the attendant problems in making tests that would truly encompass the operating parameters, any predictions of performance must be made using a combination of empirical data, test results and known performance limitations. From Bullington, Egli and tests a suggested procedure for arriving at a design criteria for remote controlled locomotive systems is:

(1) Table 1 indicates the recom-



MARION, N.C. quadrangle in which radio propagation tests were conducted.

mended fade margins for the various types of terrain, from flat to extreme irregularities of approximately 1000 feet.

(2) Fig. 1 exemplifies a comparison of VHF and UHF systems using equipment presently being marketed for this service to provide 99 percent link continuity over irregular terrain having 200-foot hills. From this example, it is determined that the locomotive consist separation should not exceed approximately one mile with 457 MHz equipment, or approximately three miles using 160 MHz equipment.

(3) Other values of maximum separation using different types of terrain and equipment performance can be deter-

	FLAT TERRAIN*	
	160 MHz	457 MHz
	27 db	38 db
IRREGULAR TERRAIN**		
Median Variations	**160 MHz**	**457 MHz**
50 feet	35 db	46 db
100 "	37 "	48 "
200 "	40 "	51 "
500 "	46 "	57 "
1000 "	52 "	63 "

* This based on Rayleigh type fading for 99 percent availability plus 7 db median different measured-calculated values for 160 MHz, plus 11 db for mobile-to-mobile service for 457 MHz.

** 160 MHz values taken from Bullington, Proceedings of IRE, January, 1950, plus 11 db mobile-to-mobile service for 457 MHz.

TABLE 1: Fade margins obtained in flat and irregular terrain.

mined by obtaining fade margins from Table 1, or performance specifications from the equipment manufacturer as to receiver sensitivity and transmitter power output.

(4) While it is recommended that actual "over the road" surveys be made to determine those sections where propagation is difficult, recordings made do not reflect instantaneous signal levels. Therefore, the approximate terrain irregularities should be determined and a fade margin selected. Where this fade margin does not provide adequate communications, such as tunnels, cuts, etc., repeater stations should be considered if track grades and train handling requirements warrant retaining continuity.

For the purpose of this discussion, the term "Loss of Continuity" refers to the inability to transmit data between the lead and slave locomotive consists because of insufficient receive carrier power.

After a predetermined period of time, the loss of continuity is displayed to the locomotive engineer by means of a light indicating "no continuity."

If no action ("Override") is taken, either manually or automatically before the "No Continuity" is indicated, the slave locomotive consists are returned to a neutral power or dynamic braking condition and the air compressors feeding the brake pipes are disconnected, resulting in a fail-safe condition.

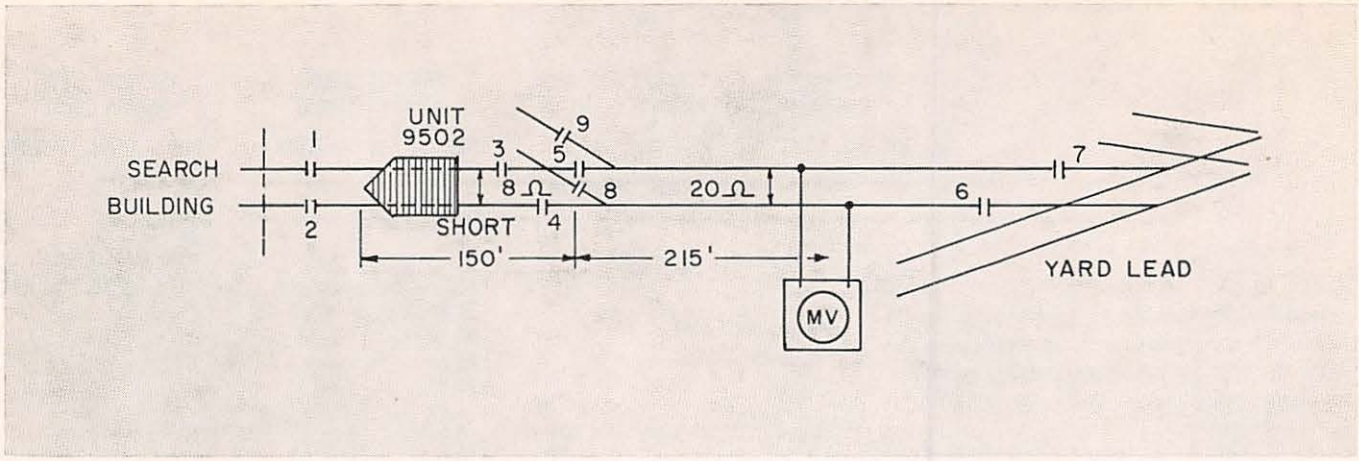
Initiating the override permits the slave locomotive consists to remain in their last commanded condition, thus providing continued application of power or dynamic braking during the no continuity period. During the no continuity condition, the override feature is nullified by any airbrake application made either from the locomotive or caboose. This nullification would also occur in the event of a loss of brake pipe continuity as would be caused by a train break-in-two. The nullification of override results in returning the slave locomotive consists to a neutral condition as described above.

It should be pointed out that when in the override condition, this does not in any way prevent regaining full control of the slave locomotive consist as soon as the receive carrier powers are of sufficient level to convey data.

PROPAGATION TESTS conducted from Ridgecrest, N.C., eastward.

Transmitter Car at Ridgecrest Depot

Receiver Car Location	Track Miles	Airline Miles	160 MHz (21W) Median Signal			457 MHz (19W) Median Signal		
			MV	MV	DBW	MV	MV	DBW
57	0.75	0.75	51			24		
			64			18		
			51			24		
			51			20		
			51	51	—103	20	20	—111
			51			20		
			51			20		
			51			18		
			40			16		
56	1.55	1.55	9.1			12		
			9.1			12		
			4.9			12		
			1.3			6		
			17.0			6		
			17.0	13	—115	6	12	—116
			13.0			12		
			6.5			8		
			9.1			12		
			17.0			12		
			13.0			12		
55	1.85	1.80	6.4			1.5		
			10.7			1.75		
			6.4			1.75		
			0.5			1.00		
			2.0	6.4	—121	1.50	1.75	—132
			6.4			2.20		
			8.0			1.50		
			5.1			2.20		
			4.0			1.75		
54	2.0	1.95	1.25			0.00		
			1.50			0.25		
			1.25			0.25		
			2.00			0.25		
			1.00			0.25		
			2.00			0.00		
			2.80	1.5	—135	0.00	Below 0.25	
			2.80			0.00		
			1.50			0.25		
			1.25			0.25		
			2.00			0.00		
			2.80			0.00		
			0.75			0.00		
53	2.35	2.15	1.5			0.5		
			2.8			0		
			2.8			0		
			2.8			0		
			4.0	2.4	—129	0.25	0.25	—147
			2.0			0.25		
			2.5			0.5		
			1.5			0.5		
			1.5			0.25		
			1.5			0.5		
52	2.7	2.3	1.5			0.25		
			0.75			0.25		
			1.25			0		
			1.25			0		
			1.25	1.25	—135	0	Below 0.25	
			1.25			0.25		
			1.25			0		
			0.5			0		
			1.0			0.25		
51	3.1	2.5	4.0			0		
			4.0			1.5		
			2.8			1.5		
			2.8	2.8	—128	0.5	1.0	—138
			1.5			1.0		
			1.0			0.25		
			1.35			1.0		
			2.8			1.75		



VARIOUS TRACK CIRCUIT CONFIGURATIONS were set up by SP for testing of interference.

Tests made to obtain extent of track circuit interference

Diesel-electric locomotives with alternators do induce electrical signals into rails.

About 18 months ago some railroads reported intermittent interferences with audio frequency track circuits, apparently produced by alternators on diesel-electric locomotives. Southern Pacific has conducted some tests in this area to determine causes and voltage levels involved. A report on the SP experience was recently published by the Committee on Electrical Equipment—Rolling Stock, Mechanical Division, AAR, and presented at the last June meeting. The report is presented herewith:

During the past six months numerous tests have been made by the Southern Pacific to determine the source and paths that couple electrical frequencies of alternator equipped locomotives with various rail circuits.

To date it has been determined that both EMD and GE diesel electric locomotives which are alternator equipped do induce a signal into the rails. These signals vary from below .25 mv to 31 mv at frequencies from 150 to 2376 Hz measured directly across the rails. Factors affecting the voltage measured at the rail or track circuit devices are numerous. Unbalanced track circuits, condition of ballast, ground resistance, capacitive action and other environmental conditions are all involved in coupling a locomotive produced frequency with track circuit devices.

Tests involving locomotive variations with constant track circuits have revealed that with the wheels of the locomotive insulated from the rail, the output signal is greatly increased. This test simulates conditions similar to using sanders which insulate the locomotive from the rails. The cables carrying current to the traction motors or dynamic brake grids appear to produce a greater signal to the rails than when the same current is short circuited within the alternator. Magnetic shorting bars placed below the alternator of one particular unit reduced the output signal nearly 50%. It is also apparent that the polarity of wiring on certain locomotives, with positive cabling on the right side and negative on the left, may be a factor in setting up a magnetic coupling.

Track areas that have a high resistance between the rails and are free of unbalanced circuits such as track switches, adjacent power lines and other electrical devices, do not appear to couple with locomotive frequencies. The voltage induced in the rails under these conditions is practically zero.

Track areas having a low resistance between rails, unbalanced track circuits, low ground resistance or other conditions that would cause a coupling with external devices appear to amplify the various alternator frequencies. With these conditions there appears to be a capacitive action between the wheels, axles or fuel tank that couples with the rail, applying a voltage at various frequencies.

An example of an unbalanced track circuit is shown above. Nine insulated joints were installed to provide the various conditions.

Voltage in excess of 6 mv across the rails will have a possible adverse effect on the track circuits.

Tests will continue to be made by the SP using the same SD45X unit. Tests are being conducted to determine the source and how the frequency is being induced into the rails. Numerous related tests are also being made to determine the coupling action of the rails and circuits under various unbalanced conditions involving low resistance roadbeds, electrolytic conditions, rail insulation and other environmental conditions.

NINE INSULATED JOINTS INSTALLED FOR TESTS

(1)	Joints	3,4,5,	jumpered	track voltage	.55 mv
(2)	"	3,4,5,7	"	" "	7.6 mv
(3)	"	3,4,7,9	"	" "	20 mv
(4)	"	5,7		" "	5.1 mv
(5)	"	5		" "	23 mv
(6)	"	5,6		" "	27.6 mv
(7)	"	5,6	(Locomotive Insulated)	" "	31.2 mv
(8)	"	3,4,5	(Locomotive Insulated & rails shorted)	" "	.235mv

NEWS BRIEFS

(Continued from page 6)

the design feature employed in these modular interlockings which require that the energized and deenergized contacts are cross checked by vital circuits for proper operation. The design of safety circuits on these premises provides a greater degree of safety than conventionally designed circuits.

The specific location of the involved modular-type interlocking is CP 132, located at Selkirk, N.Y. This is the only location for which relief is now sought.

A module is a package of circuits consisting of resistors, condensers, miniature relays, etc. wired for a specific function. As an example, an SW1 module is for a single switch, an SW2 module is for an interlocked crossover, an SG1 module is for a one-unit interlocked signal and an SG module is for a two or three unit signal. These modules are connected together electrically by means of plug couplers. Several of these types of modules connected together complete the circuitry for an entire interlocking. The signals, switches, line controls, track and approach circuits are directly connected to the modules and not through the conventional relays used in other systems. The miniature relays within the modules perform the functions of the conventional relays used in other systems.

The modular signaling system was installed at Selkirk in December, 1968. There have been no false proceed signal failures since this system was installed. However, there has been an average of five false restrictive failures per week caused by dirty contacts on the miniature relays.

The average daily traffic at Selkirk consists of approximately 15 freight trains in each direction. Switching movements are also made in the territory involved. The maximum authorized speed is 30 mph.

Although the module is not airtight in itself, the relay rack appears to be fitted with a metal cover and sealed and it appears that dust would be kept out if the cover is kept securely in place. Therefore, it is apparent that applicant intends that the cover should remain in place at all times except when it becomes necessary to inspect or service the installation.

It appears that the existing installation has been in service over two years, with approximately 15,000 train and switching movements made over it in the two-year period, all accomplished without a single false proceed signal failure.

The protestant (Brotherhood of Locomotive Engineers) argues that there have been a number of signal failures at the involved location. And that safety requires a continuation of the two-year testing requirement even as to this particular type of installation.

The informal record indicates that all of the signal failures referred to by the protestant were false restrictive failures. That is, the failures have all been on the safe side.

The involved type of system is viewed, at least by some experts, as advanced technology in the field of railway signaling and from information supplied informally it is represented that this type of installation has been tried in Europe and is working well there.

All things considered the informal record is persuasive that the sought relief should be granted on a trial basis and that it would be consistent with railroad safety if granted on that trial-type-basis and subject to further order for good cause shown. It is also clear that each module-type installation should be considered separately, at least for the time being, therefore this order shall apply only to the here involved Selkirk installation.

Premises considered, it is hereby ordered that the sought relief should be granted subject however (1) to further order at any time, for good cause shown, and (2) to the further condition that it shall apply only at Selkirk and shall not be considered as granting any relief for such miniature relays as may be used in other modular-type interlockings at any other location.

Salt River Project to electrify

A 50-kv electrification project will provide power and automation for the new Black Mesa & Lake Powell railroad. Under construction by the Morrison-Knudsen Co., Inc., this 80-mile long, totally-automated railroad will serve the Navajo Generating Station near Page, Ariz. The 2.31-million kilowatt power project, being constructed at a cost of $637 million, will be operated by the Salt River Project on behalf of itself, the Arizona Public Service Co., Tucson Gas & Electric Co., Los Angeles Department of Water and Power, Nevada Power Co., and the U.S. Bureau of Reclamation.

In addition to three 6,000-hp, thyristor-controlled, all-electric locomotives (equivalent diesel-electric horsepower rating), General Electric will also supply the substation equipment and complete automation.

Phillips monitors car fleet by CPU

A real-time computing system known as REDCAP (Real-time Entry Daily Carrier Activity Program) monitors the performance of approximately 5,000 freight cars used by Phillips Petroleum Co. serving its own and customers' needs.

Car status reports—also customer orders—are sent via Bell System lines from 220 communications terminals across the country to a pair of IBM 360/65 computers at Bartlesville, Okla. Information concerning arrivals, unloading, loading, departures, diversions and delays for repair as well as estimated arrival times at Phillips plants and customers' sidings are sent to the computer complex.

Phillips is interested in monitoring the operation of its own fleet which includes 635 covered hoppers and 2,944 tank cars. Also monitored under the REDCAP system are cars Phillips leases, plus those of other manufacturers and railroads carrying products to and from Phillips plants. Incidentally, the Phillips freight car fleet (PSPX car reporting marks) is completely equipped with ACI labels.

Under REDCAP, all Phillips railcars are continually tracked by the system. A daily exception report lists data on each car that is not moving according to pre-established standards. A trained expeditor, using this information, checks out the delay. The sales department is advised too, so that its personnel may take appropriate action. Soon, this notification will be automatically produced. The system also provides inquiry capability for the salesmen.

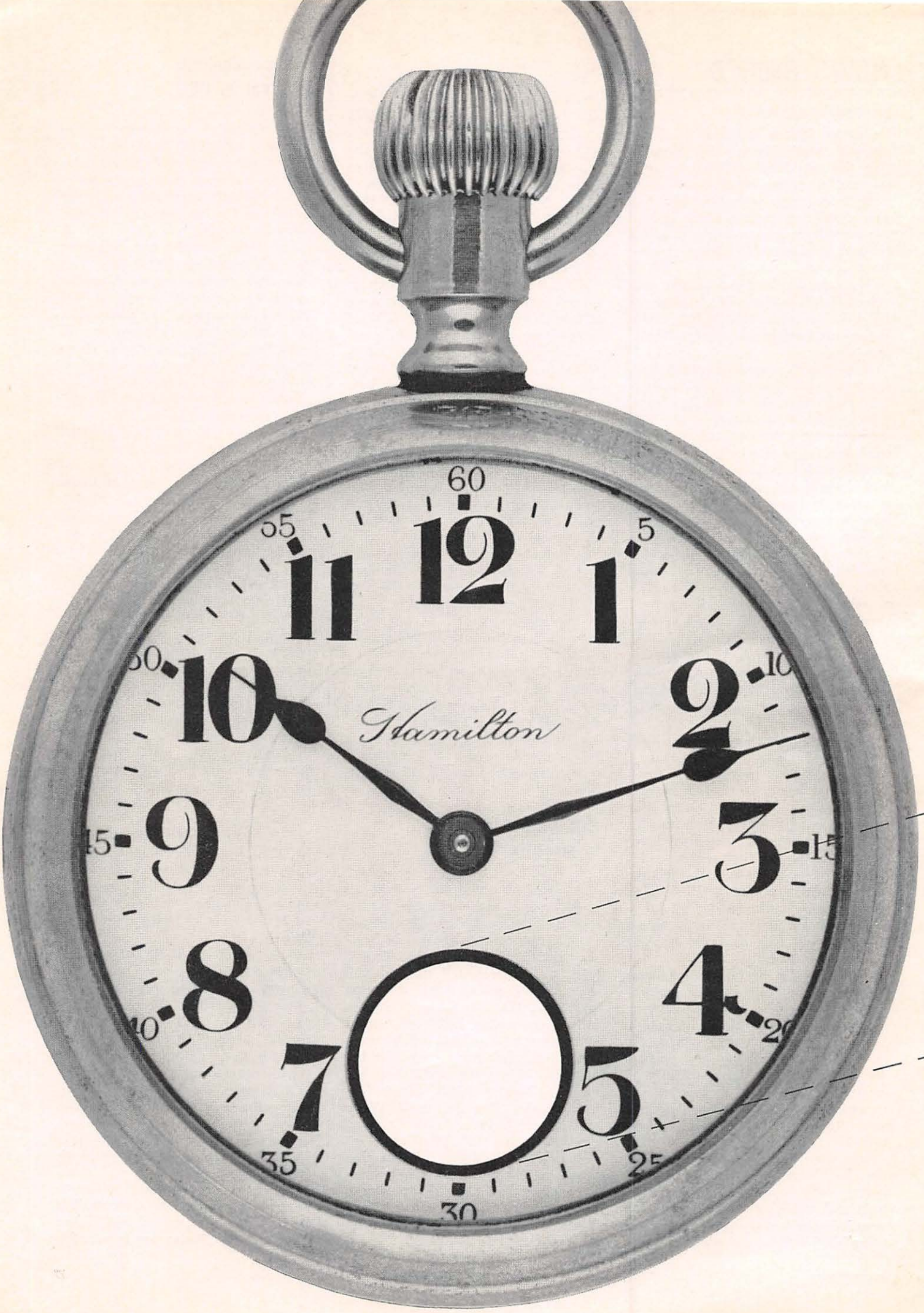
"After four years of operation, REDCAP has increased car utilization 12% and improved customer service by providing pertinent information to anyone who needs it," says Charles W. Haas, director of railway transportation.

"The efficiency of REDCAP helps to offset inflationary costs by improving mileage earnings and slowing the growth of our fleet. We expect 1971 to be the best year in modern times for the rail fleet. There are many reasons for this but the most important is real-time information," Haas says.

A message switching system, eliminates the usual polling of outlying offices. This has reduced circuit requirements at least 25%, according to H. A. Brooks, supervisor of communications operations.

When an outlying station wishes to originate a message, the operator dials Bartlesville on an inward WATS line

(Please turn to page 26)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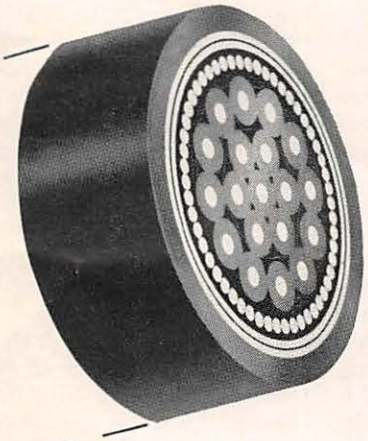

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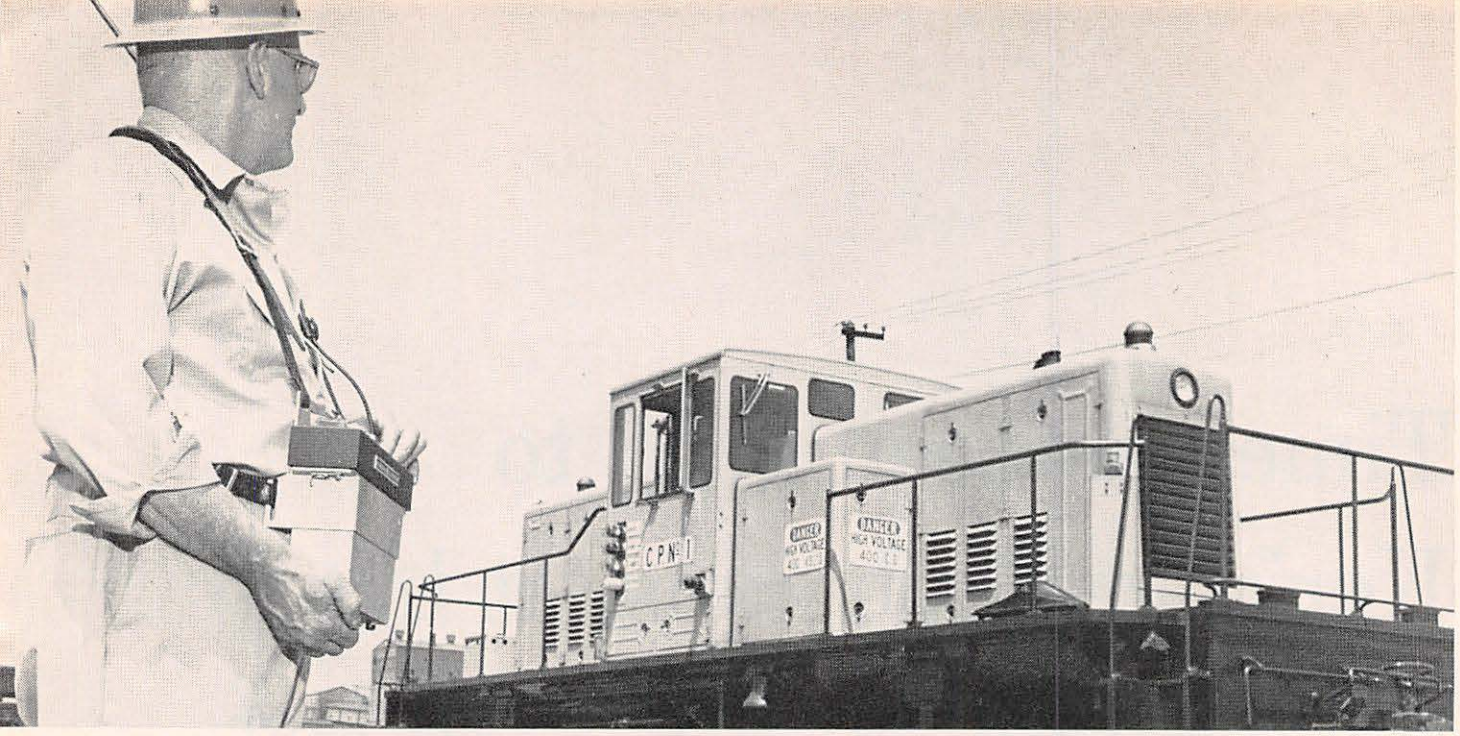


OPERATOR CONTROLS LOCOMOTIVE by radio if he is within 2,000 ft of it.

PCM used for remote controls

By THOMAS L. VANDERVORT
System Application Engineer
Off-Highway Vehicle Products
General Electric Co.

The General Electric pulse code modulated (PCM) radio remote control system is designed to meet the complete requirements for remote operation of mining, industrial and railroad locomotives by an operator who is up to 2,000 ft from the unit.

Up to 30 locomotives, with 15 commands to each, can be controlled from separate transmitters operating on a single licensed frequency. A self synchronous feature of the system insures reliability of transmissions to the locomotives. The equipment operates in the 72-76 MHz or 150-174 MHz frequency range and meets all FCC requirements for permanent licensing, including the 0.5 watt transmitter output maximum.

Figure 1 shows a basic block diagram of the system which indicates its major components and signal flow. Each transmitter is equipped with a double conversion (crystal controlled) superhetradyne RF receiver tuned to the system carrier frequency. This RF receiver monitors the system frequency and controls transmitter output in accordance with other transmitters on the system. Essentially, the RF receiver "listens" for free air time before allowing a transmission to be initiated. Discrete listening times associated with each RF receiver cause all transmitters which are in use at a particular time to fall into a repeating synchronized transmitting pattern. For a 30 transmitter system, each transmitter would be on the air once every 500 milliseconds. Transmitter analog and digital circuitry establishes the repetition rate of the transmissions, generates synchronizing, address and command bits, and keys and modulates the RF transmitter to obtain the output.

Each PCM receiver consists of a double conversion (crystal controlled) superhetradyne RF receiver feeding analog and digital circuitry. The A and D circuitry is synchronized with the transmitter, verifies the incoming address and commands and sets up the command logic for proper functioning of the relay drivers. The output of the relay drivers feeds a group of interface relays which in turn drive the relays and magnetic contactors on the locomotive.

This PCM radio remote system's transmitter and receiver antennae are vertically polarized whips. The transmitter antenna is attached to an adjustable chest harness which the locomotive operator uses to carry the transmitter in front of himself. The transmitter weighs 7 lb and measures 9½" wide, 3¼" deep and 8½" high. The receiver antenna is mounted on the best and most convenient point on the locomotive for required reception.

Eight hours of operating power for the transmitter is derived from a rechargeable nickel cadmium battery with a 5 volt DC and 15 volt DC output. It is located in the bottom of the transmitter, when the transmitter is upright, and is removed through a trap door for recharging. The RF transceiver is powered by +15 volt DC, while the remaining circuitry, with the exception of a dead man circuit, uses +5 volt DC.

The receiver obtains its power from the locomotive battery and auxiliary system, usually 75 or 37½ volts DC nominal. In any case 37½ volt DC is applied to a receiver power supply card which provides regulated +5 and +15 volt DC outputs. The 15 volt supply can be adjusted, the 5 volt supply is set by a zener diode. The RF receiver uses only the higher voltage. The power supply card also contains a crow bar circuit, which is designed for blowing of the supply fuse if its output voltage is too high. It is nothing more than an SCR configuration which is turned on in the event of a potentially damaging supply voltage. The SCR passes sufficient current to burn out the supply fuse in this case.

Reference to Figure 2 shows a more detailed block diagram of the transmitter around which its discussion will be oriented. Note that some blocks have two parts to emphasize their close functional ties without presenting the total circuitry. The transmitter emits a pulse code modulated signal, which is FM modulation of the carrier broken into logical bits by the digital logic circuitry to be described later. A typical 16 bit, 10 millisecond transmitter word might look as in Figure 3. The first two bits of this word are synchronizing pulses. Bit 3 is always blank, and bits 4 through 9 form the address portion of the message, which allows selection of a particular receiver (locomotive) of a possible 30 in use. Bit 10 is blank and bits

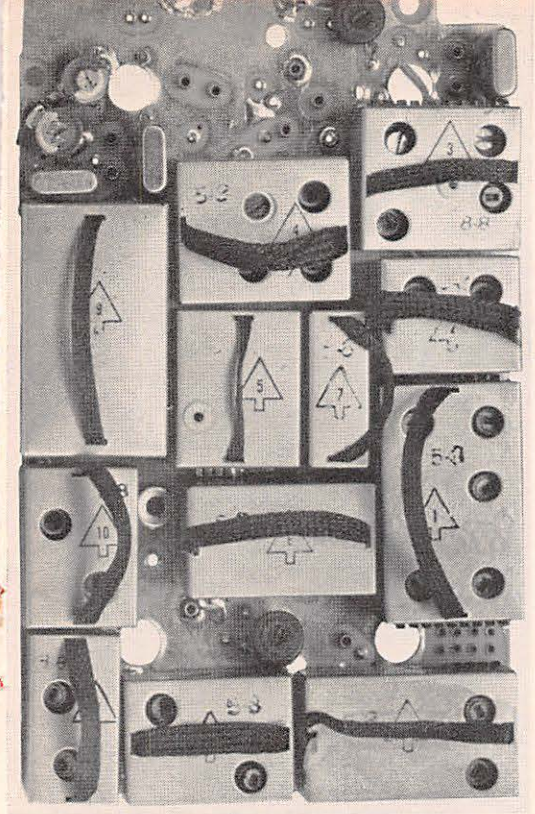


PHOTO 1—RF transceiver board.

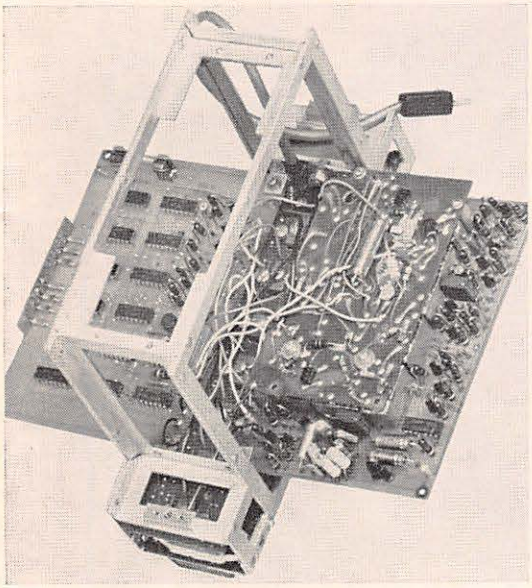
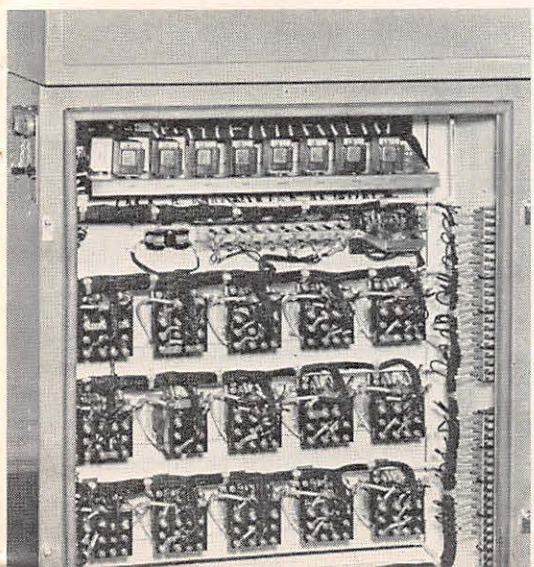


PHOTO 2—Inside of transmitter.

PHOTO 3—Loco interface relays.



11 through 15 form the command functions, which are the actions requested of the locomotive. Bit 16 is blank.

The presence of a bit can be thought of as a logical '1,' and its absence a logical '0.' The two sync pulses must always be present to cause a locomotive receiver to respond. Similarly the correct address pulses (the number and configuration) must always be present to cause a locomotive receiver to respond, the necessity of which will be discussed later when the receiver is described. The address configuration will change to any of 30 possible combinations which is chosen. The particular one shown is 100111. The configuration and number of command pulses will also change depending on which of the 15 combinations is selected for a function to be performed. The particular command shown is 10100.

A word, such as in Figure 3, is emitted from the transmitter with each burst of RF energy from the RF transmitter. The rate of this emission is either 2 or 4 times a second (500 or 250 milliseconds between pulses). These two rates are determined by the gated timer (self sync, controller), which is basically a single shot integrated circuit. Its RC time constant circuit is changed accordingly by a selector plug. Associated with this timer circuit is an approximate 5 millisecond "listening time" during which a gated timer hold off is initiated such that it will not be triggered as long as another transmitter is emitting on the same frequency. The gated timer pulse, when it is allowed to occur, starts the transmitter logic sequence described below (continue to refer to Figure 2).

A system enable flip-flop is triggered by the gated timer, which in turn gates a bit generator and keys the RF transmitter through the modulator module. Due to an adjustable 4 millisecond delay in the modulation signal, which comes from the code gate output, this modulator keying signal insures that the RF transmitter oscillator is fully on (oscillator located in modulator module) before modulation is applied.

The bit generator has a twin T oscillator configuration, which has an adjustment rheostat for a 2 KHz ±2Hz frequency setting, and a raised cosine generator. The latter is essentially an overdriven amplifier which shifts the level of the oscillator input and suppresses the negative half cycle, hence the bit shape of Figure 3. Its output is taken across a potentiometer, so that the deviation (FM modulation) of the RF output can be precisely set.

The code gate is basically an "or" circuit which permits pulse coding the output of the raised cosine generator (modulation signal) sequentially with the sync, address and command generator output. These latter three select the bit configuration, i.e. bit or blank positions.

The sync, address and command generator is scanned by a synchronous counter which establishes the 16 bit increments (16 counts) of the transmitter word.

The bit generator 2 KHz oscillator output is pulse shaped and used as the clock pulse for the synchronous counter. The shaping detail is not of great importance, suffice it to say that a Schmitt trigger and pulse amplifier stages are used.

The sync., address and command generator circuits are quite similar to each other in their configuration. A nand gate integrated circuit is provided for each bit generated. These gates 'and' high level inputs (logical '1') and 'or' any low level inputs (logical '0'): that is, if all the nand gate inputs are 1's then the gate output is logical '0', if any of the input gates are '0', then the gate output is logical '1' (see Figure 4).

Thus for the generation of two sync pulses (refer to Figures 3 and 4) appropriate outputs are taken from the counter outputs such that during the first count all the inputs to one nand gate are '1' and its corresponding '0' output is inverted and represents the first sync pulse. Similarly the second count results in a second sync pulse from a second sync nand gate.

It should be noted that for simplicity the bit shape as shown in Figure 3 is referred to in this discussion as that which exists throughout the digital and analog circuitry. Actually it is the raised cosine generator output while the digital circuitry bits are rectangular, such as from the sync, address and command generator.

Each of the address bits is sequentially generated by six nand gates which respond to their respective counter outputs such that each generates an address bit at the proper time. The address nand gates (as shown in Figure 4) have a fifth input (expander input) which is used to delete that particular bit. As would be true of the inputs, when the expander input receives a low level '0' the nand gates output is a '1'. This when inverted by a following integrated circuit to '0', yields a blank in that particular address bit position. Thus any of the six address bits may be deleted by simply connecting the desired expander gate to common. This is accomplished through an address receptacle and plug system on the transmitter. The six pins of the address plug are either left open '1' or connected to common '0'. Thirty of the possible pin connection combinations are used as address selection choices. The example of Figure 3 would be produced by connecting the expander inputs of the sec-

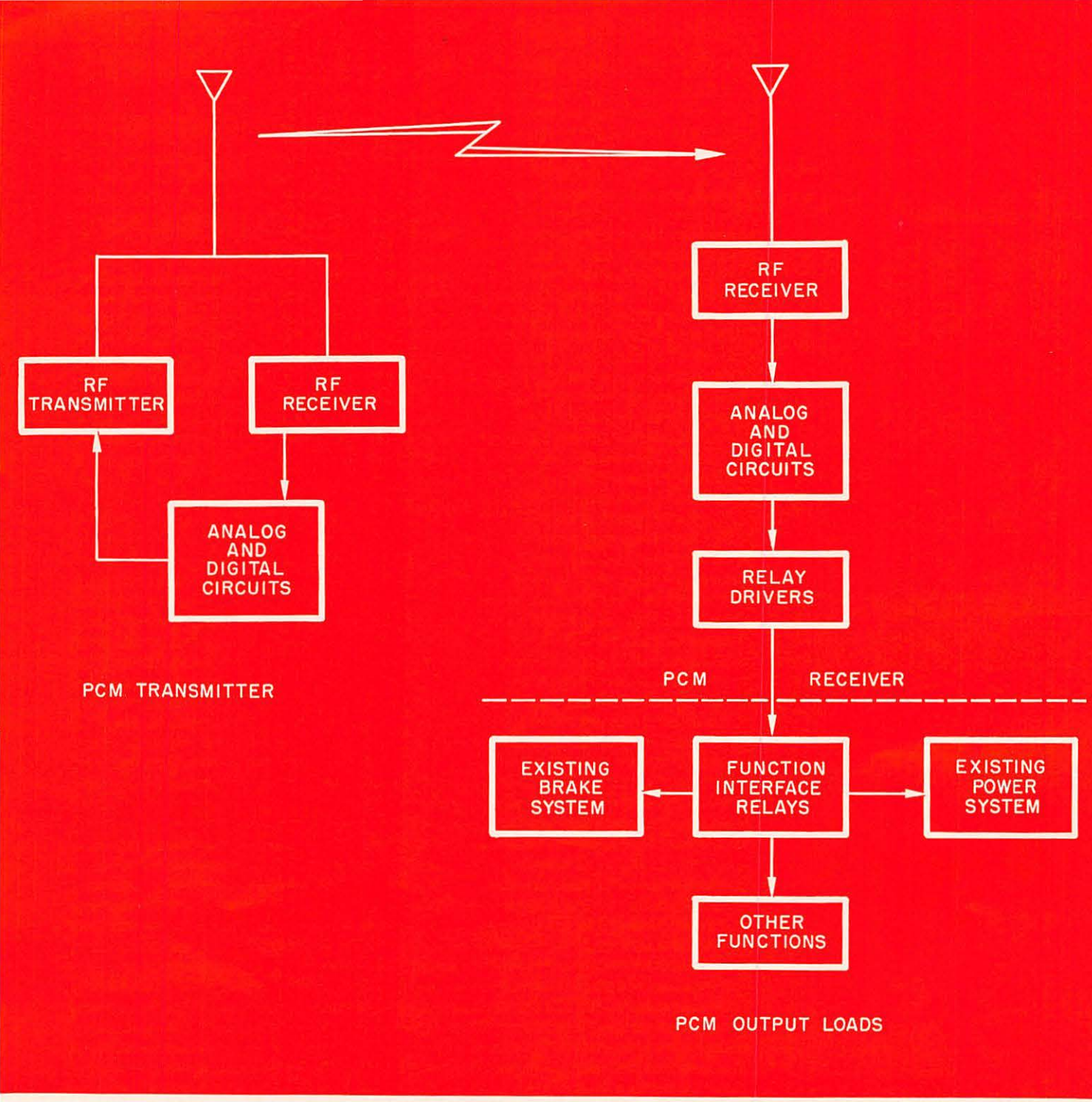


FIGURE 1—Basic pulse code modulation system for remote control of locomotives.

ond and third nand gate, at the address plug, to common.

Generation of the command bits is also accomplished through the use of the inverting nand gate. Five such gates and corresponding bits are possible. Instead of connecting these gate expander inputs to a plug, as with the address gates, they are connected to a diode matrix. The diode matrix is wired such that a toggle switch places some of the diodes, hence their expander inputs, to '0' or leaves some of the diodes open '1' into the nand gate. Fifteen command combinations are used, each being initiated by the front panel switches. The command as shown in Figure 3 omits the second, fourth and fifth bits, but generates the first and third.

Two command switches activated at the same time will result in no command output or will allow an odd number of bits to be transmitted which will not pass the receiver parity check. This two command inhibit is accomplished by another integrated circuit and the diode matrix. The parity check will be discussed further when the operation of the receiver is presented.

Photo 1 is that of the RF transceiver board which is part of the transmitter. The circuitry is modular constructed; they plug into the printed circuit board and therefore, replacements can be made on a unitized basis. Seven of the modules shown constitute the receiver and the remaining five constitute the transmitter. The receiver double conversion crystals are both next to module 9 and the transmitter crystal next to module 3.

As previously mentioned, the function of the RF receiver in the PCM transmitter is to "listen" for other transmitters on its frequency and inhibit its transmitter output, until the frequency is clear. It does this by applying its squelch output to the gated timer such that the gated timer cannot function until no other RF signal is present (no receiver squelch output volts).

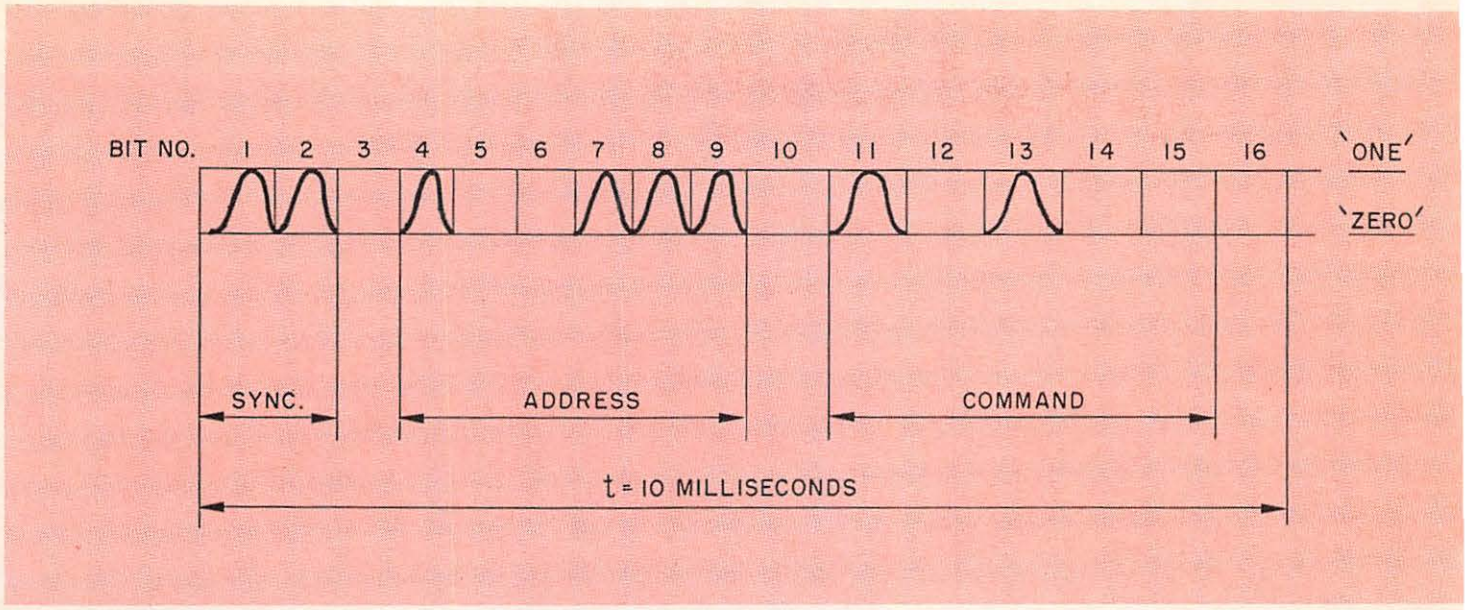


FIGURE 3—Pulse code modulated word used in the remote control system.

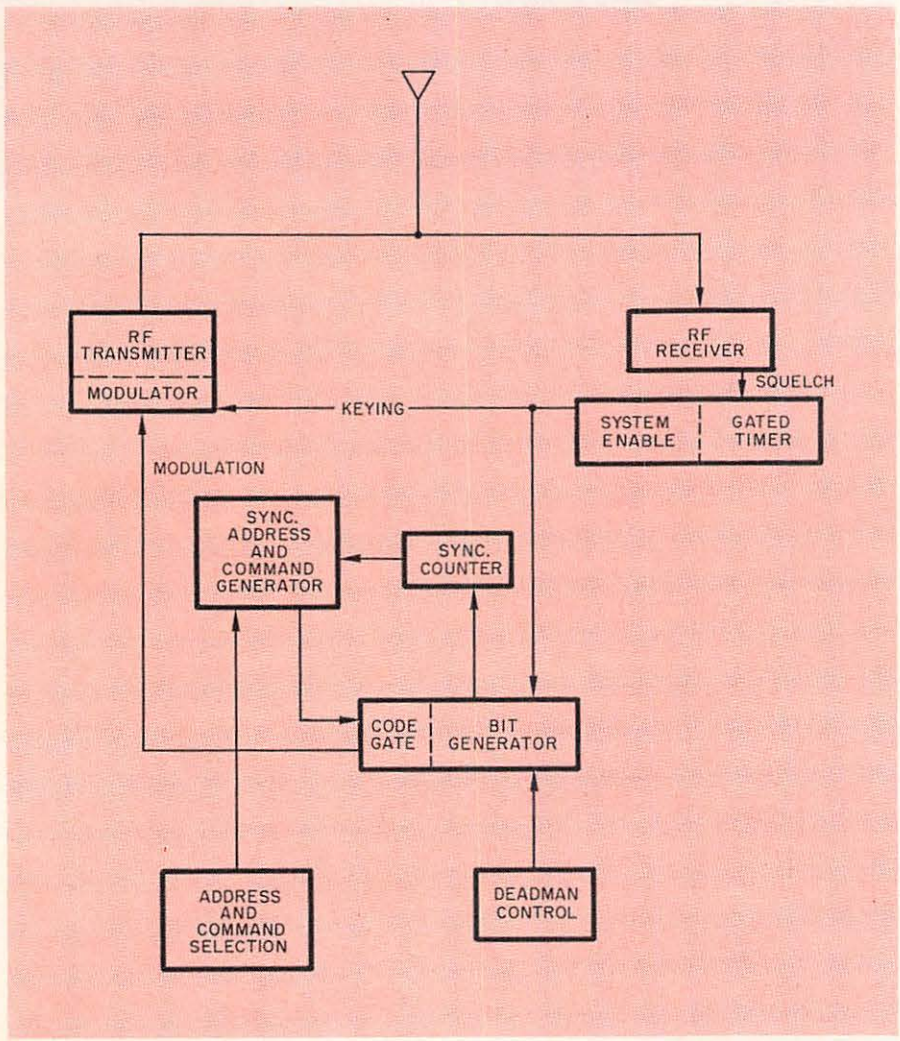


FIGURE 2—Pulse code modulated transmitter used for controls.

Up to 30 transmitters in a system will transmit in any given 500 millisecond period if that respective gated timer period is chosen by the selector plug, one other option is 250 msecs. This will be so because even if each worst case transmitter 'on' time is said to be 15 milliseconds, 50 milliseconds should remain of the 500, when no transmitter should be on (500 msec. cycle time-30 units x 15ms = 50ms). The same concept limits the number of transmitters to 15 when the 250 msec. period is selected.

Photo 2 shows an inside view of the transmitter. Note that the circuit boards are hinged and shown open. When secured they are each pivoted up and fixed parallel to the frame.

The right hand board contains the RF section and most of the discrete components. Note that the cards are double sided printed circuit cards. The address plug is on the left edge of the left hand card.

The bases of the command switches can be seen between the main cards, and although the diode matrix card is around the switch bases, it cannot be seen well here. It is merely a printed circuit board with 50 glass bead diodes (150 ma) mounted on it and appropriate connector points.

The rechargeable battery supply, 5 and 15 volts DC, plug can be seen at the top of the transmitter frame.

Not shown is the deadman control circuit board, which is mounted perpendicular to the boards shown, in the frame ends. This circuit contains a mercury switch, which by virtue of its physical alignment on the transmitter, when the board is mounted, is normally closed when the transmitter is in the upright position (as when the unit is worn by an operator). If for any reason the transmitter deviates more than 60° ±15° from the vertical for a period of more than 4 seconds, the modulation is suppressed at the bit generator and only the RF carrier is transmitted. Actually the time of response is adjustable from 2 to 6 seconds, but it is generally set at 4 seconds.

The receiver is perhaps digital logically more complicated than the transmitter, though in block diagram form as per Figure 5, this may not appear to be so.

The PCM radio receiver is mounted in its enclosure which will be installed

on a locomotive. Along the bottom of the enclosure are noise suppressing feed through capacitors for all leads which protrude from the bottom for connections to the functional relay panel upon which it is mounted. The receiver circuitry is mounted on 5 plug-in cards with the exception of the RF receiver which is placed in the metal enclosure mounted at the right of the 366 card. Note that the cards have front jacks where the important signal information can be measured without removing them. The RC receiver is identical to that in the transmitter and shown in Photo 1 except, of course, the transmitter modules are absent, and an additional audio amplifier module is mounted next to module 4 which supplies the amplified message to the digital logic.

The squelch output of the RF receiver is used as a gating signal which sets up the receiver logic for its response to the coming of a transmitter message. The squelch output is fed to what could be called the sync control timer, which is a rather complex logic configuration, whose main function is to precisely sequence a gated unijunction oscillator, so that its output is in exact phase with the transmitted address and command bits. The first two message bits, the sync pulses, are key to this accomplishment. These two sync bits cause the sync control timer to key its unijunction oscillator of very narrow pulses, such that they are in the center of the transmitted address and command bits.

The synchronization of the receiver unijunction oscillator with the transmitted address and command signals is quite analogous to standard television vertical and horizontal sweep synchronization. The scanning of the TV receiver must be sequenced with the transmitter scanning for usable results, thus sync pulses are transmitted for the receiver vertical and horizontal oscillator synchronization or locking-in. The PCM transmitter and receiver share the same principle. If synchronization is lost in the PCM system, the transmissions cannot be properly interpreted by the receiver.

With the timing established by the squelch and sync pulses, the address and command pulses from the RF receiver are inputed to a shift register respectively. The shift register consists of six IC units serially related, so that it stores the address and commands for use. The outputs of each of the shift registers IC's is applied to the input of a nand gate (the same configuration as discussed in the transmitter section and seen in Figure 4, except two inputs into diodes are fed into the expander gate)

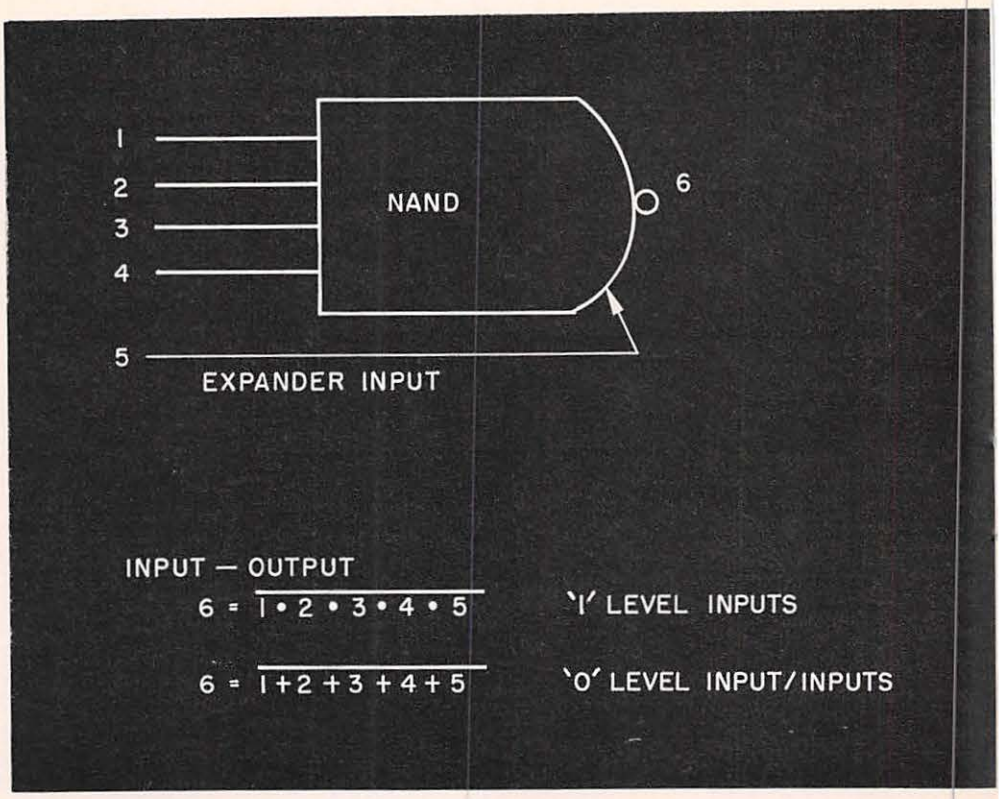


FIGURE 4—Nand gate integrated circuit logic diagram.

such that the proper address into the register produces a low level output, i.e. all logic '1' inputs yields a logic '0' output from the nand gate. A '0' input from any of the shift registers to the nand gate indicates an invalid address. This constitutes address validation. A valid address sets up the command logic. An invalid address through the use of further digital logic causes the control timer to reset until the next transmission. The invalid address response persists as long as the transmitted address and the address programmer selection do not agree.

The address programmer is no more than the selection of the '1' or '0' side of the shift register flip-flop outputs through the use of selecting plugs in accordance with the desired address. The six plugs are connected to the outputs of each flip-flop such that all '1' levels are obtained with the correct address, then applied to the nand gate as discussed above.

A valid address causes setting up of the command logic so that it will respond to the incoming commands. The commands are inputed to the shift register and interpreted by the command logic. The important functions of the command logic are its throttle notching and reversing circuitry.

The notching logic will increase one step at a time in response to each press of the transmitter 'power on' button. It will also decrease one notch at a time in response to each press of the 'throttle retard.' Both seven and eight notch throttle capabilities are available simply by using either a 369 or 371 card respectively. Both have a zero notch (coast) position also. Basically, the only difference between cards is the addition of more IC logic to the seven notch card to provide the eight.

The reverser circuit is on the same card as the notching circuitry and is interlocked with it. Their interlocking prevents the reverser from being thrown in any notch position except the zero notch. The reverser circuit is an IC flip-flop whose position is controlled by either of two nand gates. Each of these two nand gates will switch the state of the reverser IC, if it is not already in the correct state, when the nand gate has a '0' output. Each nand gate has a '0' output with respect to a given direction. That is when the 'forward' switch is pressed one nand gate has all '1' inputs. The other nand gate receives all '1' inputs only when the 'reverse' switch is activated. These will be true only if the throttle notch is zero. If the throttle notch is other than zero a '0' input will appear into one input of each of the two nand gates, both nand gate outputs will be '1', and the reverser flip-flop cannot change state.

Transmission detectors are used in the receiver which will, in the absence of the transmitter signal for more than one second, reset the throttle notch to

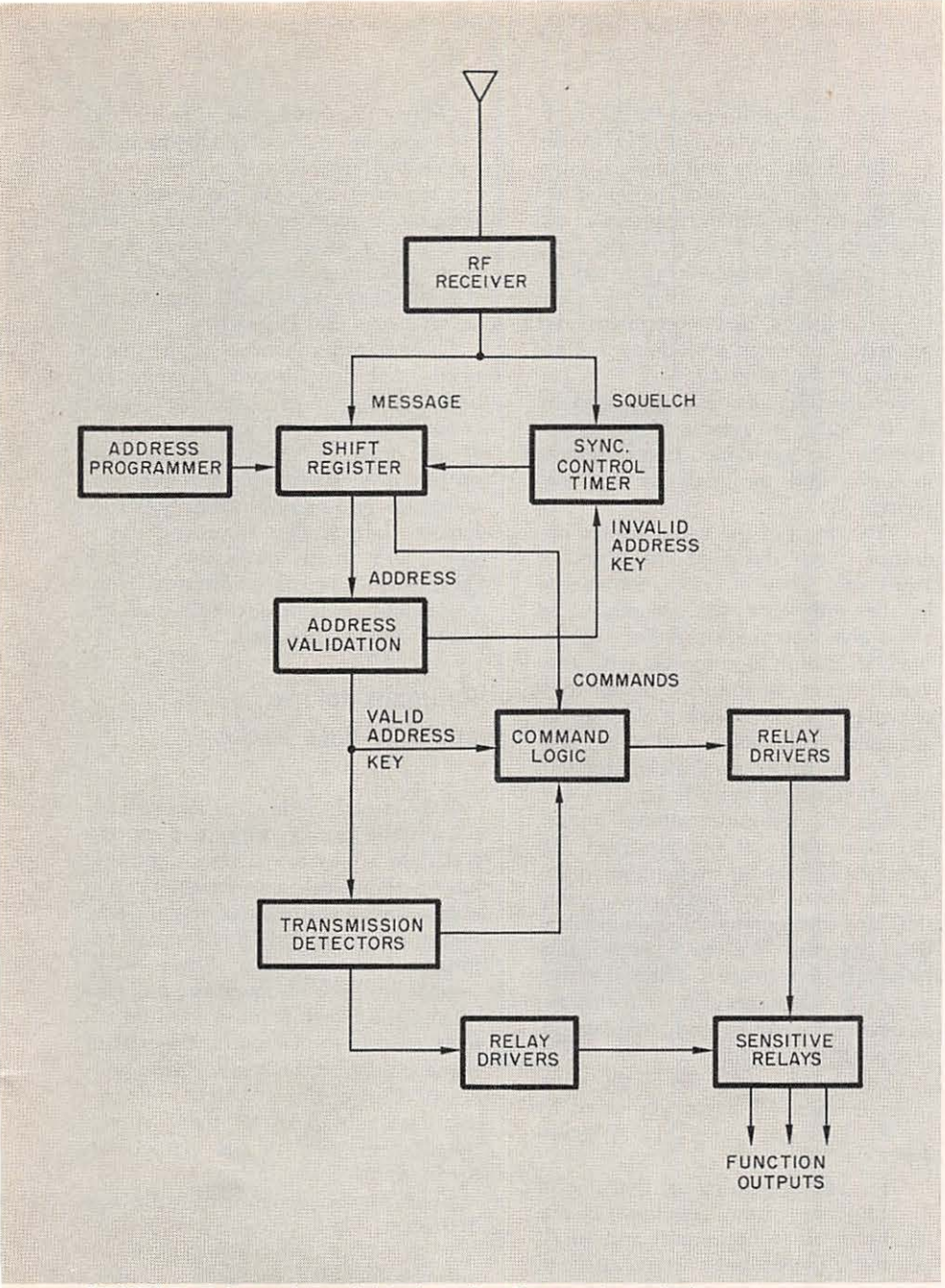


FIGURE 5—Pulse code modulated receiver for remote controls.

zero and apply braking through relays. Returning to zero notch is accomplished by re-setting the throttle notching logic associated flip-flops to their initial state. Two transmission detectors are actually used to provide safety redundancy. They both receive their input from the address validation output.

The transmission detectors as well as the 15 command logic circuits must provide relay driving power to ultimately activate the locomotive switching circuitry. Thus, they all have relay drivers, hex inverters, as the last output stage. These IC units are power amplifiers which can provide 4.8 ma DC to the 1,100 ohm sensitive relays. Reference to Photo 3, shows these sensitive relays mounted in a horizontal line across the top of the bottom group. They plug into sockets for easy service. The other relays in Photo 3 are the function interface relays, which interface between the above mentioned sensitive relays and the on board locomotive relays and contactors.

Note that the assembly of Photo 3 has the the receiver (door closed) mounted in its housing attached to the top of the lower group. The assembly weighs approximately 350 lb. and measures 48" high, 32" wide and 12" deep. The switch on the left hand side of the bottom group is for switching between manual and remote, while the light indicates radio remote is in control.

This PCM radio remote system is designed with a minimum of adjustments, consistent with good engineering practice, in order to keep its maintenance and repair procedures as simple as possible.

The transmitter has an adjustment for its 2KHz oscillator (clock generator), which is set within 0.1%. An adjustable delay of 4.0 ±0.5 milliseconds is used between the keying of the oscillator and counter, thus insuring that the turn on time of the RF transmitter is allowed for, and the first bit generated is not a partial bit. The 'dead man' time-delay circuit, as mentioned, is adjustable from 2 to 6 seconds, though generally it is set as 4 seconds. This provides the operator time to perform a short task, such as uncoupling or track switching, without interfering with the locomotive operation.

The RF transmitter and receiver, of course, have typical alignment procedures which essentially maximize the overall gain by peaking circuit modules. It is not necessary to discuss these fully here, suffice it to say that only a properly FCC licensed individual may align the transmitter and attest to its correctness. This must be done with an FCC acceptably accurate frequency meter, watt meter and deviation meter.

The transmitter frequency is adjusted by a crystal trimmer to within 50 Hz of the FCC assigned frequency. Its output power must be set with a power level adjustment within 475 ±25 milliwatts at +15 ±0.2 volt DC battery. Its deviation is set, with the potentiometer output of the raised cosine generator, within ±2.4 +0.1 KHz in the 150.8 to 174 MHz range and ±6.7 +.3 KHz in the 72 to 76 MHz range. The transmitter must only be adjusted when connected to a 50 ohm dummy load. Working into this load will also prevent overdriving the on-board receiver when the two units are in close proximity.

It should be remembered that the transmitter is pulsing at 2 or 4 times per second in normal operation. Hence some of the parameters subject to adjustment are difficult to work with and set. But, continuous transmitter operation is easily established for adjustment purposes by connecting a steady state keying signal (+5 volt DC), to the appropriate system enable output point. This is a continuous system enable output in effect.

The transmitter listening and on board locomotive receivers each have a squelch control which is ultimately adjusted for maximum receiver sensitivity consistent with acceptable noise immunity. The sensitivity of these RF receivers will be less than 1 microvolt when operating and tuned properly.

The on board locomotive RF receiver also has an audio gain control, which is set so that it will fully drive the pulse shaping circuitry and ultimately the sync control timer and shift register. The unijunction oscillator is adjustable with respect to the incoming bit messages, so that its clock pulses occur at the center of the transmitted bits (synchronization of the receiver with the transmitter).

NEWS BRIEFS

(Continued from page 17)

and, by use of a short request for service, instructs the computer to dial back on an outgoing circuit. Meanwhile, the prepared message tape with a suitable header is inserted in the outlying station's transmitter. As soon as the computer calls back, the message is sent. The system handles about 5,000 messages a day, averaging 500 characters each.

If Bartlesville wishes to transmit to an outlying station, the message is entered into the computer, preceded by an address header containing all necessary control information. The computer selects the proper circuits, holds the message until they are available, and then dials the appropriate stations and transmits the message.

CP rail considers electrification

CP Rail is vitally interested in electrifying 850 miles of its lines west of Calgary, Alta. with a 50,000-volt AC system. S. M. Gossage, senior executive officer of the CP Rail, recently told the Canadian Transport Commission that electrification of the mainline from Calgary, Alta., to Vancouver, B.C., and from Golden, B.C. to Sparwood, B.C., "would offer operating advantages that would enable operation up the controlling grades at higher speed and also would enable a faster movement of trains from a stop in sidings or at other points and thereby would tend to increase capacity." CP Rail is predicting a doubling of bulk traffic over its Rocky Mountain lines during this decade.

Decade outlook covers system controls

In recent interviews in the *Railway Age*, three railroad top executives mentioned system controls as a key area for intensive work during the decade of the 1970s. Speaking of technology, B. F. Biaggini, president, Southern Pacific, had this to say:

"Specifically, though, I look forward in the next 10 years to important advances in the freight-car truck, automatic coupling, grade crossing protection, yard and terminal design, computer-aided dispatching, surveillance and signal systems, data exchange through the industry, intermodal containers, environmental controls, use of new materials, and product reliability to reduce maintenance costs and avoid service interruptions.

"I look forward to more R&D interface with new technological advances in other fields here and abroad, more use of simulation and mathematical models as we expand research and engineering uses of the computer, and more frequent closely-coordinated efforts with shippers along technical lines, to design new equipment and services, cut costs and develop new markets," Biaggini said.

Service reliability was discussed by D. B. Jenks, president, Missouri Pacific, and he mentioned improvements in yards and terminals as key elements.

"First, most of the yards now in operation were designed 50 years or more ago. They are not adequate to handle today's traffic smoothly, let alone the increased traffic of the future. It is time to come up with new yard designs, to improve on the best of what we have today. Using the computer technology now at our disposal, we could accurately simulate operation of new yard designs.

"Second, communications among the railroads must be improved. All railroads should be exchanging information about car movements, using standard and compatible communications systems. We have found that terminal performance improves dramatically when accurate information is received early enough to plan operations," Jenks said.

The function and role of the computer in railroading was discussed by A. E. Perlman, president, Western Pacific.

"It would appear to me that one of the most important functions is the obtaining of accurate unit and product costs. Better unit costing can lead to greater efficiency in operations, and product costs can be of immense aid in pricing and market research.

"Three other "great contribution" roles for computer science/technology would be:

"—In the field of command and control equipment which can lead to greater automation in our operations.

"—In the field of market research, where many of the now-imponderable variables can be equated in the computer to obtain better solutions to our marketing problems.

"—In the field of the total management system concept, where one memory core can furnish uniform, detailed and expedited management information at all levels of supervision as deemed necessary, which can lead to more intelligent and more timely management decisions," Perlman said.

Concerning roadway, W. T. Rice, chairman and chief executive officer, Seaboard Coast Line, said:

"Major improvements in yards and terminals are necessary. This includes upgrading of present facilities; modification, and in some cases, automation, of existing terminals; and construction of additional major classification facilities, a need intensified by the introduction of run-through trains involving several railroads.

"Route improvement is a major need, including improved signaling and installation of centralized traffic control on additional segments of line. It also includes major improvements on new routes available through consolidation and merger which presently handle light traffic. Improved alignment and grade on many existing routes will permit substantial improvement in both schedule and impact factors," Rice said.

Railroads to use cpu's as data banks

"The trend, today, is increasingly toward the use of computers as central data banks for all key operating information, with fast communication access and manipulation of data providing accurate and timely operating information, simulation of new or alternate methods of operation, and producing the information needed for effective decision-making on the part of management at all levels," said Robert B. Curry, vice-president management systems, AAR, at the 25th national conference of the Association for Computing Machinery.

Four significant industry-wide undertakings cited by Curry as indicative of the progress being made by railroads included automatic car identification, TRAIN (TeleRail Automated Information Network), UMLER (Universal Machine Language Equipment Register) and the Per Diem Summary Exchange Project. Describing this per diem exchange project, Curry said:

"Since the successful pilot project in 1967, the railroad industry in the U.S. and Canada has carried out a joint project for the exchange of monthly per diem summary records of freight cars on magnetic tape with the AAR's Data Center acting as a clearing house. In the current exchange program each participating railroad furnishes the AAR a magnetic tape containing all the per diem summary records of freight cars for each of the other participating railroads. The AAR Data Center consolidates the car records received, sorts them, and mails to each participant a reel of magnetic tape containing that railroad's records.

(Please turn to page 29)

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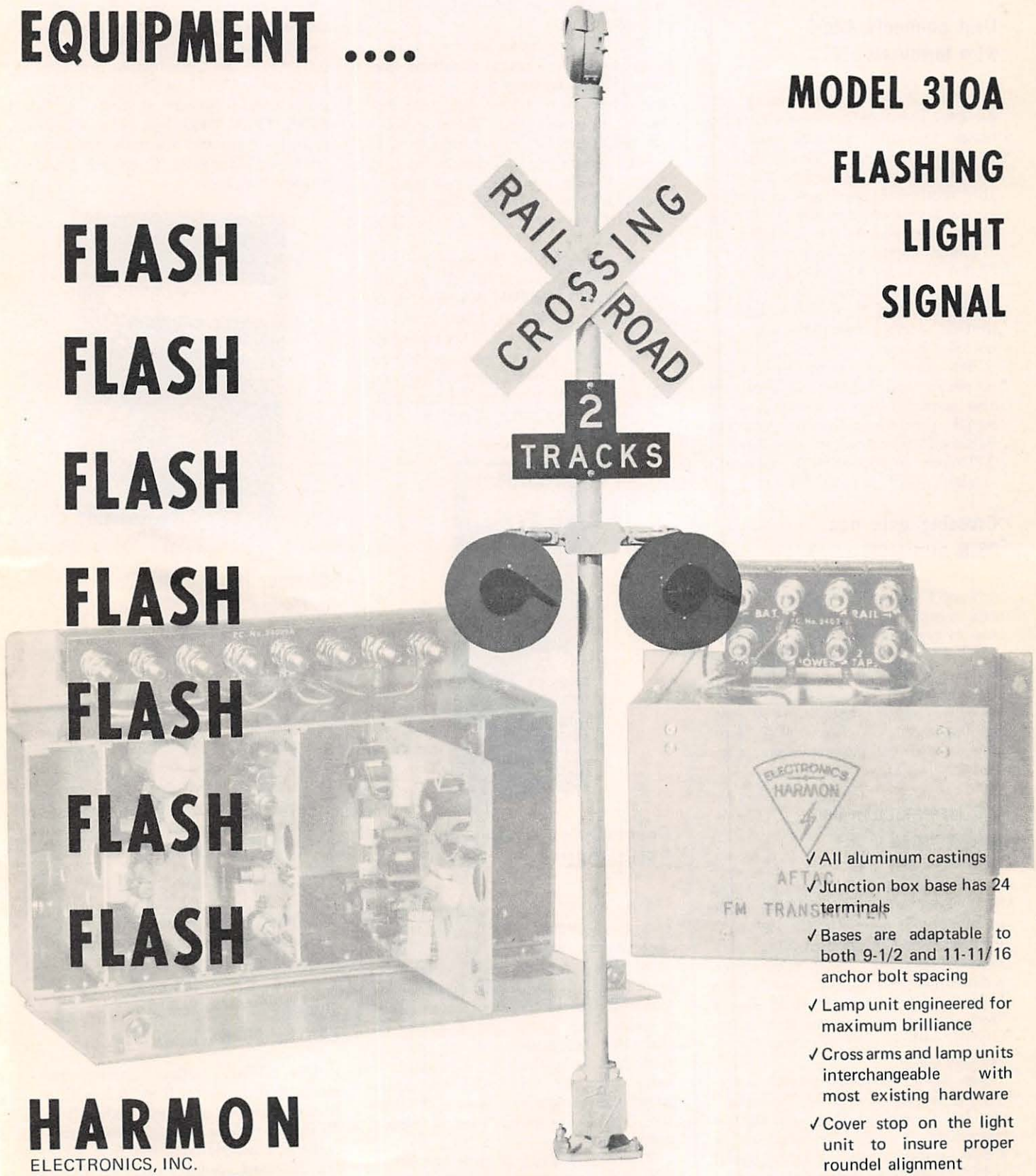

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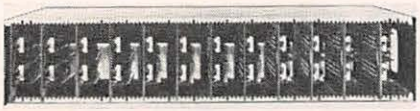
Product News



Unit connects 4-to-2 wire terminals (101)

A new four-wire terminating unit provides high-quality connections between four-wire facilities and two-wire office equipment. Designated the 5540A, the unit introduces a switchable method of performing attenuation adjustments. Settings in 0.1 dB steps range from 0 dB to 16.5 dB.

Other important features of the 5540A include A and B leads for signaling facilities carrying current up to 120 ma, and D, F and G leads to provide control functions when required. Integral network build-out (NBO) leads are strappable for the proper network balance, and leads are also provided for connection to external precision-balanced networks. Balanced two-wire drop impedance of 600 ohms or 900 ohms is optionally available. *GTE-Lenkurt Inc.*

Crossing gate has 25 ft arm (102)

Type F automatic highway crossing gate is capable of clearing a 25 ft gate arm in eight seconds. Type XC flashing lights feature a parabolic mirror and precision lamp and roundel which provides a light beam over a quarter mile in bright sunlight. The gate mechanism has a 12-volt DC, four-pole, permanent magnet motor. *General Railway Signal Co.*

I/O terminal can be programmed (103)

The typewriter-like terminal (IBM 3735) can be programmed to guide an operator step-by-step through each document, keeping errors to a minimum. It performs basic calculations, automatically stores data on its own large-capacity magnetic disk file or "buffer" and can communicate unattended with a central computer at high speeds.

The 3735's keyboard printer, a version of the familiar IBM "Selectric," can be placed anywhere an electric typewriter is normally used—on a a desk, stand or table. Printing speed is 15.5 characters a second.

Basic storage capacity of the disk file is 62,800 bytes of information, typically enough to hold a full day's production plus the user's programs. Two additional increments of 41,800 bytes each can be added, for a total of 146,400.

The 3735 uses the binary synchronous method of communications line control. The terminal can be used on switched point-to-point (dial-up) lines, nonswitched point-to-point (leased) lines or in multipoint networks. When used in multipoint networks, 3735s can share communications facilities with other binary synchronous terminals such as the IBM 2770 or 2780.

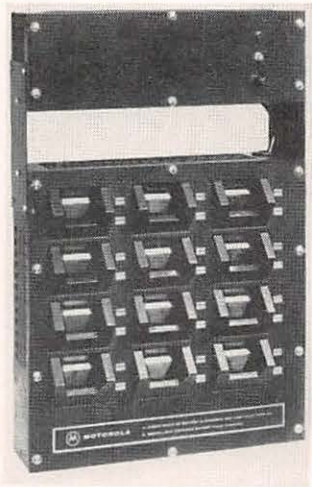
Data entered by the operator and stored on the unit's disk file can be transmitted to an IBM System/370 or most System/360s at 1,200 2,000 or 2,400 bits per second. This transmission, as well as data being sent from the central computer to the 3735, can take place with the terminal unattended. *Data Processing Division, IBM Corp.*

Concentrator handles CPU-to-CPU data (104)

The CC-71 communications concentrator controls simultaneous communications between a large number of regionally located remote computer terminals and a central computer, and concentrates this communication into a single high speed line. Located in the same geographic area as the remote terminals, the CC-71 communicates with the terminals over low-speed communications lines and with the central computer over a high-speed line.

The CC-71 provides full line control and multiplexing, terminal polling, code conversion, error control and message assembly/disassembly.

The CC-71 handles both full and half duplex communications lines at all standard transmission rates. The communications between the terminals and the CC-71 is generally low-speed at rates of 110, 150, or 300 bps; while the transmission line connecting the CC-71 to the central computer would operate at 1800, 2400, 3600, 4800, 9600 bps. The CC-71 can also communicate with terminals at these higher rates. *Computer Communications Inc.*



Charger is for radio batteries (105)

Designed for the HT 220 series Handie-Talkie portable two-way radios, new single and multiple-unit chargers are completely automatic and eliminate the danger of overcharging. Once a battery is dropped into the charger, a red light comes on indicating the battery is charging. When the battery is fully charged—in one hour or less—a green light comes on indicating the battery is ready for use.

The multiple unit version will accomodate up to 12 batteries and is available in desk or wall mount configurations. *Motorola Communications & Electronics Inc.*

Overlay circuit can be 20 ft (106)

The ED5001 island overlay has shunting distances of 5 to 20 ft with a ring by distance of approximately 5 to 10 ft. Thirty-four channels of frequencies are available from 510.5 to 1320 Hz. *Railroad Division of Erico Products Inc.*

(Please turn to page 30)

NEWS BRIEFS

(Continued from page 26)

"Previously, railroads had exchanged this data with each other by mailing punched card forms. The magnetic tape exchange produces economies by reducing card punching, reducing mailing costs and computer run time on all the railroads.

"Participation has grown from the initial three roads involved in the pilot project to 32 railroads covering 79 reporting marks with a combined ownership of over 1,340,000 freight cars. The AAR is now handling more than 1,360,000 records per month in this exchange program," Curry said.

In another area of industry cooperation, Curry mentioned the exchange of computer programs and said that the present issue of the Data Systems Division's Applications Digest consists of 111 computer applications of operations research running from the abstract to the practical, from such things as statistical regression analysis to bridge-girder stress analysis.

"Individually, also, railroads have progressed management science applications in their own roads with 18 roads having one or multiple management science applications in operation, many dealing with train operations, track analysis, PERT or critical path scheduling, linear programming, etc.; profit analysis, statistical analysis, and financial planning, as well as many engineering designs and analyses," Curry said.

Speaking of the future, Curry had these comments: "In all probability the industry is nearing the point of saturation as far as number of computers are concerned, but not as related to the size and capacity of computer systems. There will be considerable upward expansion in size and complexity of computers, in the extent of computer peripherals, and in the scope and number of remote terminals.

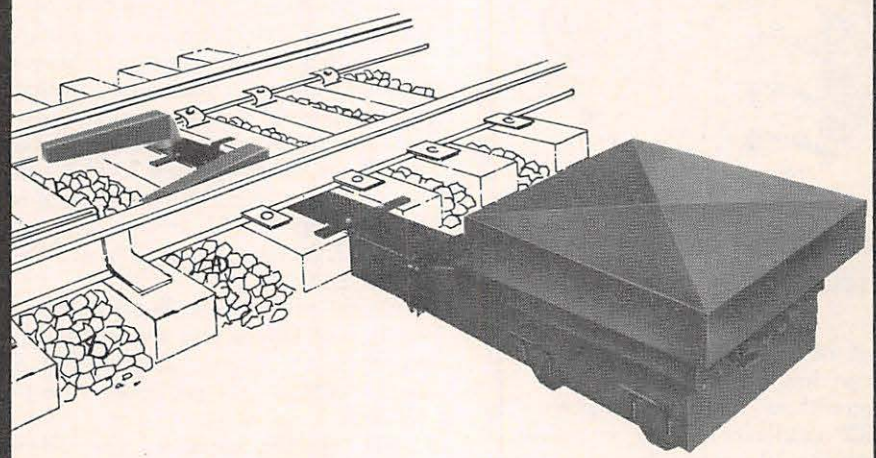
"There will be further expansion of on-line, real-time information systems. There will be greater interroad exchange of data via computer communications, as well as exchange through the AAR as a clearing house for data exchange.

"There will be greater employment of management science applications by railroads with even greater sophistication of advance mathematical techniques.

"There will be concerted efforts to quantify quality, to measure service performance, particularly on interroad freight movements," Curry said.

NEW!

RAILS COMPANY HAB SWITCH HEATERS



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All components located for easy installation and servicing - separate remote control panel is free from trackside vibration. Hot air duct is electrically insulated against track circuit interference and designed to provide maximum air flow.

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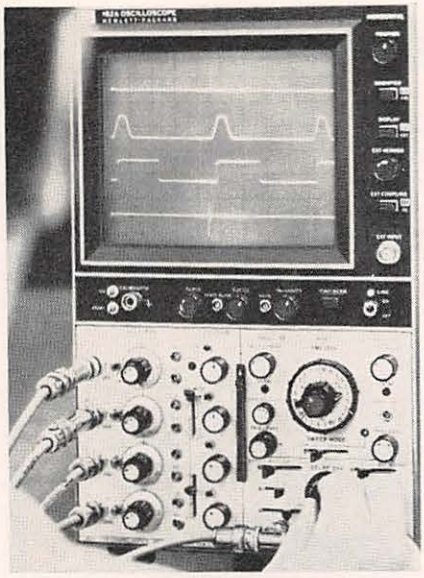
Circle 8 on reader service card

PRODUCT NEWS

(Continued from page 28)



Oscilloscope has large display (107)

A new all-purpose, plug in oscilloscope has a CRT display area 85% larger than 8 x 10 cm displays. The CRT graticule has the conventional form (8 x 10 squares) but each square is 1.34 cm on a side. One of 13 plug-ins for this instrument gives it 100MHz response.

Like others in the HP 180-series oscilloscope it accepts without modification all plug-ins designed for the 180A/181A scopes, including a 100MHz dual-channel vertical amplifier, a 50MHz four-channel amplifier, a differential/dc offset amplifier, delaying sweep time bases, and a time domain reflectometer. The 182A mainframe has the same width (7⅞") as other 180-series mainframes but is slightly higher (13") to accommodate the larger display area. Length is 22". *Hewlett-Packard Co.*

Many instruments in test system (108)

The FM-10 is a complete AM/FM/SSB test system combining several instruments in one, and is a broadband, continuous spectrum device operating in the 50 KHz to 1,000 MHz range.

The FM-10 will: Align transmitters to channel frequencies with 0.0001% accuracy and 10 cycle resolution. Measure carrier frequencies, local oscillator frequencies, IF's, any frequency in the 50 KHz to 1GHz range. Measure receiver sensitivity with precision 80db attenuator range plus automatic leveling. Generate precise audio signals (50 Hz to 5 KHz) for testing tone circuits. Measure bandpass characteristics of filters, amplifiers, and mixers. Calibrate and test discriminators and ratio detectors. Measure peak deviation of an FM transmitter. Monitor demodulated audio visually for noise, spikes, or waveform distortion. *Singer Instrumentation*

Alarm system is for monitoring (109)

The Quind-Alarm system is a remote monitoring system initially developed for the supervision of alarms at unattended microwave repeater stations. Printed circuits are treated with conformal coating to permit operation under adverse environmental conditions. In its simplest form it can be used to monitor up to 40 points at as many as 27 remote stations over a frequency bandwidth of 300-3,000 Hz.

Conditions such as illegal entry or equipment failure at a remote station signal to the master station that a fault exists at that particular remote location.

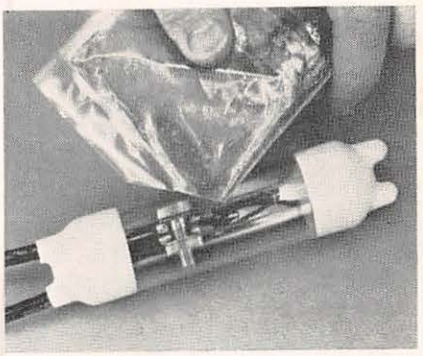
The specific cause of the alarm may be identified by switching the common alarm decoding equipment to the address of the particular station signaling trouble. *Quindar Electronics Inc.*

Portable unit measures noise and level (110)

A new compact, portable test instrument, the ENLS-A noise and level measuring set measures noise levels from −2 to +112 dBrn and signal levels from −92 to +22dBm. The measured noise or signal can be weighted by either 3kHz flat or C-message weighting, according to the announcement.

Measurements may be made for metallic noise or signal levels on 600- or 900-ohm circuits in either terminated or bridged connection. Noise-to-ground measurements can also be made. The test set automatically provides the industry standard correction on noise-to-ground measurements.

The solid state unit measures 7" x 11" x 8", weighs 12 lb and operates on ordinary flashlight batteries. *Elgin Electronics Inc.*



Encapsulation closure is for cables (111)

An encapsulation closure for splicing communication cables and signal wires has butt, in-line, or buried splice work applications.

The Pee Wee Closure is a small but complete kit and includes a high speed Q-compound which sets in five minutes at 70°F. Designed for one and two-pair wire, it will accept multi-conductor wire up to ¼" outside diameter. Compound pouring area is closed off with a barrel action, and friction-fit of parts gives tight, dependable holding.

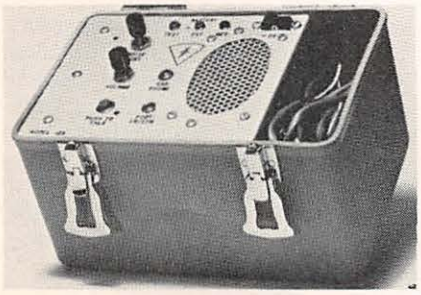
End caps of soft vinyl are snipped off to accommodate the size of wires to be spliced. The barrel clamp bonds the wire shielding (aluminum and copper) without tools; conductors are simply inserted, and the clamp screws together to effect bonding. After splicing conductors, the Clipper Pak of Q-compound is quickly mixed in its own plastic bag, then poured into the Pee Wee Closure slot. The outer clear plastic barrel is then twisted to close off the pouring area, and after 5 minutes setting time the neat closure protects against the elements and may be buried or not, as required. *Communications Technology Corp.*

Software and computer reports updated (112)

Software Reports is a multi-volume current-awareness service that provides information on commercially available proprietary software. Business, scientific and engineering, systems software, operations research and

management sciences will be covered in applications grouping for easy reference and comparisons. The heart of the service will be the package reports that contain pricing, operational characteristics, hardware requirements and support and training facilities for significant packages currently being marketed.

Minicomputer Reports is a three-volume looseleaf reference set containing complete and comprehensive coverage of the most significant minicomputers on the market. System reports describe minicomputer characteristics necessary to "mix and match" them to the user's needs. Conveniently charted information includes summary of hardware, software and I/O equipment; system configuration; internal storage elements; central processor facilities and features; price data, etc. *Auerbach Info, Inc.*

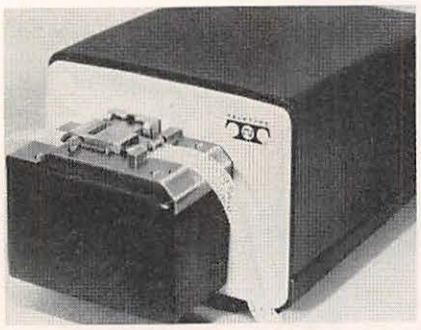


Carrier phone is portable (113)

A portable carrier phone is designed to provide communication over existing lines without interference to existing signals of other frequencies. The unit would normally be used while installing or maintaining CTC systems, hot box detectors, or anything requiring communications between two points up to 100 miles. The unit is available in frequencies from 35KHz to 300KHz and is AM modulated. It features push to talk with hands free foot switch, speaker monitoring, earphone monitoring, battery operation with built-in battery charger, external 12 volt DC jack, modulation limiter, and automatic volume control. *Harmon Electronics, Inc.*

Battery chargers are solid-state (114)

A line of solid-state battery chargers, with both unfiltered and filtered outputs, are listed in a revised catalog SC-306. Units are specifically designed for "float" service for both nickel cadmium and lead-acid storage batteries, with or without a connected load. The charger adjusts its output current automatically according to the load and the requirements of the battery. A "high-rate" charge setting, initiated by a manually set timer, allows a discharged battery to be charged rapidly. *Nife Inc.*



Tape reader operates up to 360 cps (115)

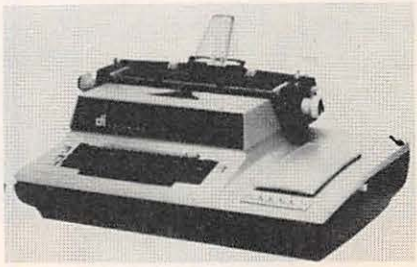
Teletype DX asynchronous paper tape reader operates at speeds from zero to 360 characters per second. The unit can read any 5 through 8 level code, including the American Standard Code for Information Interchange (ASCII). The reader has diode-transistor-logic input and output, allowing interface at the DTL level. Either parallel or serial output signal is available. *Teletype Corp.*

Temperature alarm is solid-state (116)

The EN-ROOT temperature alarm system consists of three compact packages. The main package is a rugged, anodized aluminum housing containing a thermistor temperature sensor and all-solid-state electronics control circuitry. This is designed to mount within the refrigerated compartment. The second package, mounted external to the refrigerated space, contains an On-Off switch, fuse, terminal block for incoming 12-volt DC power, and a test switch to check for proper system operation. The third package is a warning device mounted external to the refrigerated compartment.

Model 100 is factory adjusted to activate an alarm when the compartment temperature rises above 0°. Model 200 actuates an alarm when the compartment temperature goes below 34°F and when it rises above 45°F. Other models can be factory-adjusted to suit individual customer temperature requirements.

Various warning devices can be controlled directly by the system output. For refrigerator cars, the use of a 12-volt DC revolving warning light is recommended for mounting on the car roof. As an option, the system output can also turn on a transmitter which will trigger a wayside receiver tied in with the railroad hotbox detector lines to indicate an alarm at a remote point. An audible alarm can also be supplied as an option. *Root Engineering, Inc.*



Data recorded remotely for sending (117)

A new system records business data at remote locations as original business information is typed, and sends this recorded data over telephone lines to a central point where it is re-recorded for preparation for computer processing. The system is made up of one or more T30 recording-transmitting typewriters and an A30 Telecassette recorder.

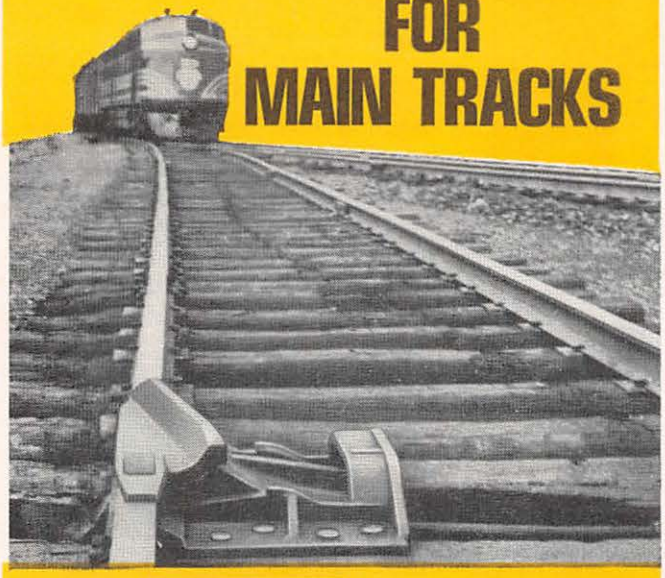
As original business paperwork is typed, the T30 records all information on a magnetic tape cassette for later transmission via telephone lines. The A30 Telecassette recorder automatically acknowledges calls from remote locations, monitors and corrects for data transmission errors, and records, on similar magnetic-tape cassettes, data sent from the T30 units. *Data Instruments Co.*

Car scale can be unattended (118)

A new scale is using a machined beam 45" long in place of a section of rail the same length. The beam is supported at each end, with strain gauges on its bottom surface. Weight of each passing wheel is measured by the strain gauges, which sense bending stresses in the weighrail. This

(Please turn to page 33)

POTENT PROTECTION FOR MAIN TRACKS



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You will never have safe main track operations until you have the protection of derails designed and proven to meet the needs of this diesel age.

In 1910, short, stubby little derails were made from castings. They didn't cover the rail head but, for the relatively light equipment, were adequate. Today's diesel tends to override them or smash the castings like crockery. Some people still make derails from castings. Thousands of early century derails are still in track.

The modern Hayes HB derail is 100% steel. It will never shatter under the impact of the heaviest car. It covers the rail head in a 30" long transverse sweep that positively lifts the wheel, diverts it over the rail head and safely deposits it outside the gauge of the track.

The Hayes Model HB Derail provides an effective physical backup to a signal system when human error occurs or it will act competently when no signals are involved.

If your main track is not protected by the HB pictured above, you can't be sure of modern protection.

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Circle 10 on reader service card

Book

New book tells about computer circuits

"Computer Circuits and How They Work" begins with a discussion of how computers work, including the "language" of computers, then proceeds to explain the principles of the central processor, the memory, control section, registers, instruction decoders, timing circuits, serial and parallel operation, phase counters, adders, counter circuits, input-output sections, etc.

The second section deals with comparators, error detection, and parity checking. Section 3 provides a comprehensive treatment of memories—the types used and how they function. The author describes the various operating modes and various performance criteria, as well as data storage and retrieval.

Section 4 is devoted entirely to circuits and applications, actual circuits designed to perform a wide variety of functions. There are memory circuits, dividers and detectors, averagers, storage and transfer devices, error checking circuits, servo stepping circuits, pulse gates, shift registers, gray-code counters, BCD-to-binary and binary-to-flip-flop circuits, multiplex circuits, log converters, add-subtract units, a high-speed binary counter, a programmable divider, TTL adders, etc. Approximately half the book is devoted to applications and circuits.

Computers and How They Work, by Byron Wels, 1970, TAB Books, Blue Ridge Summit, Pa. 17214, 192 pages, Price: $7.95 hardbound, $4.95 paperbound.

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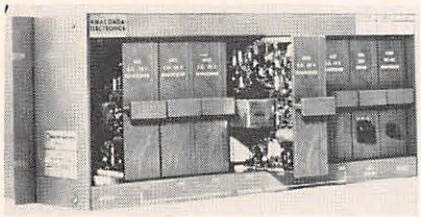
PRODUCT NEWS

(Continued from page 31)

scale is installed on a slab of reinforced concrete. There is no pit, the scale structure is simply bolted to the top of the concrete. The scale has no moving parts or mechanically triggered switches. One total weight for each car is recorded by a standard Teletype printer which can be remotely located. This scale is unattended. *Sands Measurement Corp.*



Station carrier has 7 circuits (119)

The S6A station carrier multiplies the circuit capacity of every existing subscriber service line by up to seven times. The S6A system offers three power options for providing DC power to the remote equipment—subscriber terminals and repeaters. Exclusive Channel X offers the flexibility of a seventh channel or a maintenance spare. As a spare, Channel X can be used permanently or temporarily in place of any of the standard six channels.

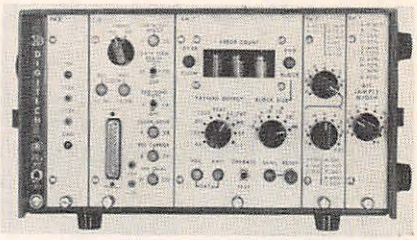
S6A is available in four basic ringing configurations. More than one ringing option can be used in the same system. (1) BFR—bridged frequency selective ringing; (2) DIV—divided frequency selective ringing; (3) SPR—super-imposed (DC bias-divided) ringing; and (4) SPS—single party service. *Anaconda Electronics.*

Facsimile operates over phone system (120)

The model 240 graphic facsimile communications system will transmit an 8½" x 11" document in 4½ minutes over the public telephone system. The equipment has automatic answer and automatic hang-up for unattended reception.

A document loader will automatically feed up to 50 documents at a time into the transmission equipment. The system operates at 240 lines/minute.

Connection to telephone lines can be via a Bell System data access arrangement, Stewart-Warner manual coupler and automatic answer coupler or private wire 2 and 4 wire connections. *Stewart-Warner Corp.*



Error rate tester puts out patterns (121)

The 2302/2301 bit error rate tester generates pseudo-random test patterns of 63, 127, 511, 1,023, 2,047 and 32,767 bits as selected by a front panel control.

Also easily selectable from the front panel is the block size to be transmitted.

Applications include data set operation and data communications facility testing on an end-to-end or loop-back basis. *Digitech Data Industries Inc.*

Do you wish you could clean 100 contacts in 10 seconds?

You can. With "Contact Re-Nu." This powerful cleansing agent in aerosol form is specially formulated to remove dirt and carbon from all kinds and sizes of electrical contacts. "Contact Re-Nu" delivers a flushing spray of solvent containing Freon TF®, which restores full continuity almost instantly to relay and switch contacts. Non-conductive, non-flammable, non-toxic; leaves no residue. Harmless to all insulation or coatings. Try "Contact Re-Nu"—FREE. Write (on letterhead, please) for regular 16 oz. can and see how quickly it takes the gunk out of your circuits.

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Circle 11 on reader service card

Editor's Corner

ASTRO PICL TRAIN

How many words in the above title are acronyms? While you ponder, here is Webster's definition: ACRONYM—a word (as *radar, snafu*) formed from the initial letter or letters of each of the successive parts or major parts of a compound term.

Only one word in the title is an acronym. It's TRAIN which stands for Tele-Rail Automated Information Network. Admittedly, selection was a bit subjective on my part from the more than 100 submitted by railroads and transit authorities in the *Railway System Controls* survey. Here's the list, and then comments about the "near misses."

ACT—Automated Car Tracing (furnished by Chicago, Rock Island & Pacific).

ARCS—Automatic Revenue Collection System (IC).

BEEF—Business and Engineering Enriched Fortran (C&O/B&O).

CAP—Commuter Advancement Program (IC).

CARES—Computer Aided Roadway Equipment System (MP).

CARS—Car Activity Regularizing Scheduler (MP).

CART—Car Analysis Report, Transportation (SP).

CAVIAR—Computer Aided Vehicle Information And Reporting (MP).

COAT—Costing Out All Traffic (UP).

COIN—Complete Operating INformation (UP).

COMPASS—Complete Operating Movement Processing And Service System (BN).

CRASH—Cars Roughly And Shockingly Handled (B&LE).

CUBE—Computer Users Burroughs Equipment (C&O/B&O).

CUBIC—Combined Union Bessemer Information Control (B&LE).

CULPRIT—CULl and PRInT (UP).

EAGLE—Early Access Geographical Location of Equipment (MP).

EASE—Elastic Analysis for Structural Engineering (C&O/B&O).

FAST—Factor Analysis Selection Technique (SOU).

FIST—Feasible Ideal System Target (C&O/B&O).

FIST—Financial Information SysTems (UP).

FRIAR—Foreign Road Interline Account Reconciliation (SP).

ICES—Integrated Civil Engineering System (C&O/B&O).

IDEALS—Ideal Design of Effective And Logical Systems (C&O/B&O).

JOBS—Joint Opportunity for Better Service (IC).

LAND—Lost ANd Damaged (SOU).

MAIN—Mid-American Information Network (IC).

MAP—Management Accounting Program (IC).

MISER—Management Information System, Equipment Reporting (SP).

MISER—Management Information Service Evaluation Report (UP).

MIST—Management Information System, Traffic (SP).

MODEM—MOdulator DEModulator (UP).

MOP—Management Orientation Program (C&O/B&O).

PACE—Planning And Controlling Expenditures (SP).

PAL—Passenger Assistance Link (IC).

PAR—Performance Analysis and Review (C&O/B&O).

PERT—Program Evaluation Review Technique (C&O/B&O).

PERT—Program Evaluation and Review Technology (UP).

RACE—Random Access Computer Equipment (C&O/B&O).

RACE—Revenue Accounting Conversion Effort (SP).

RAGS—Railway Action GroupS (C&O/B&O).

RAT—Rent-A-Train (IC).

RAMPS—Resource Allocation, Multiple Project Scheduling (C&O/B&O).

REACT—Realistic Estimate to All Costs to Trains (SOO).

RUDE—Report of Uncorrect Detail Error (IC).

SALT—Symbolic Assembly Language Translator (C&O/B&O).

SCOOP—System Computer Oriented OPerations (N&W).

SCORE—Scheduling, COntrol, and Reporting systEm (SP).

SEAL—Special Equipment Assignment List (C&O/B&O).

SEARCH—System Evaluation And Reliability CHecker (CP Rail, C&O/B&O, SOU).

SHARE—Society to Help Avoid Redundant Effort (C&O/B&O).

SPAR—Special Projects And Reports (SP).

SPINS—Shippers Perpetual Inventory Numbering System (BN).

SPINS—Southern Pacific Industrial Numbering Systems (SP).

SPINS—Specific Placement on INdustry Spot (UP).

SPOT—System for Provision Of Transportation (CP Rail).

SPOT—Service Procedure On Track (STL-SF).

SPOT IT—Specific Placement On Terminal Industry Track (UP).

SPUR—Simultaneous Processing Unit Records (SP).

SUN—System Utilization Network (N&W).

TABS—Transportation And Billing System (PC).

TACTIC—Train And Car Total Information Control (B&LE).

TIP—Track Identification Program (UP).

TIT BIT—Top Inside Temperature and Bottom Inside Temperature of reefer cars (CP Rail).

TO—TurnOut (SOU).

TOPS—Total Operations Processing System (SP, UP).

TOSS—Terminal Operating Service System (C&O/B&O).

TRAP—Temporarily Released Auto Parts (C&O/B&O).

TRIM—Temporarily Released Interrupted Movement (C&O/B&O).

TRIP—Traffic Report Inquiry Program (SP).

TRUE—Temporarily Released Unusable Elsewhere (C&O/B&O).

WASP—Waybill Accounting Services Project (SP).

YARDS—Yard Activity Realtime Decision Simulator (MP).

Words Not Included

Near miss words included the computer terms such as COBOL (COmmon Business Oriented Language); words like DOT (Department of Transportation) that stand for proper names; or proper names such as ADAM (Automatic Distribution of Administrative Messages).

Some interesting near miss words included the following, which, when pronounced, sound like the correctly spelled words.

GAPP—Grade crossing Accident Prevention Program (IC).

MIS—Market Information Systems (UP).

SCUF—Super Cushion Underframe Car (SOU).

SPEC—System for Planning Evaluation and Control (CP Rail).

STRUDL—STRUctural Design Language (C&O/B&O).

WATS—Wide Area Telephone Service (UP).

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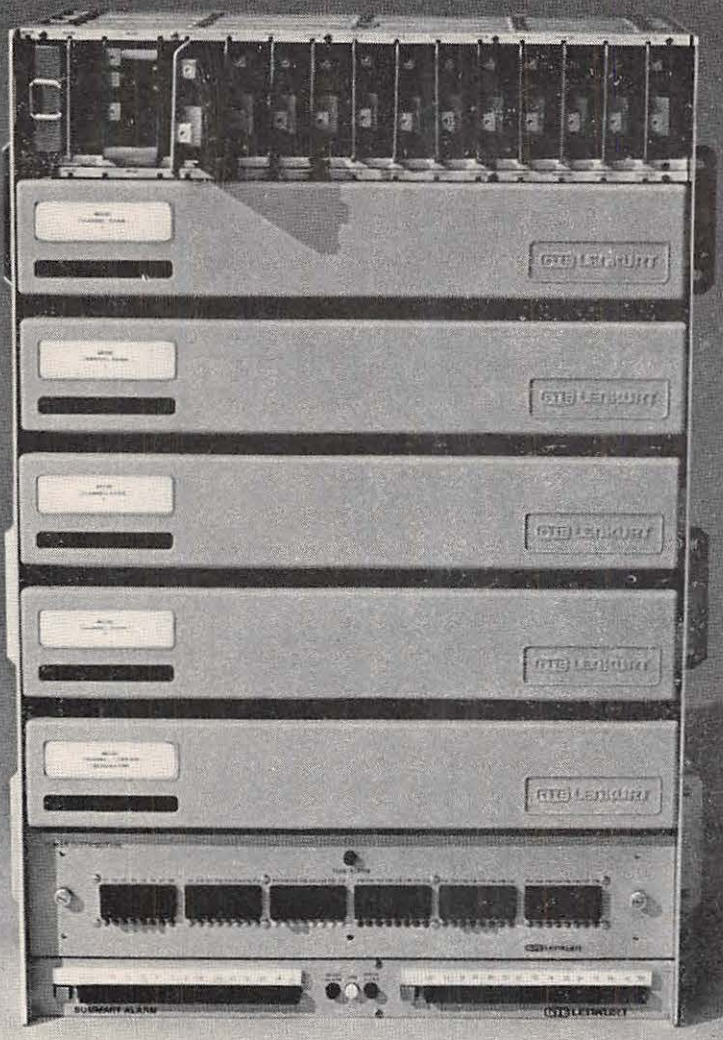

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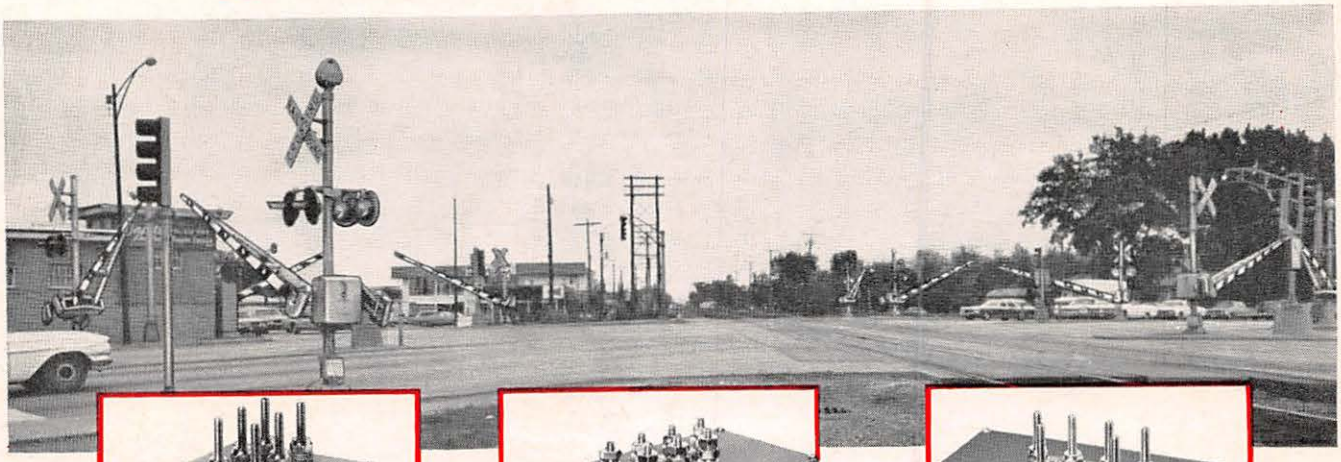

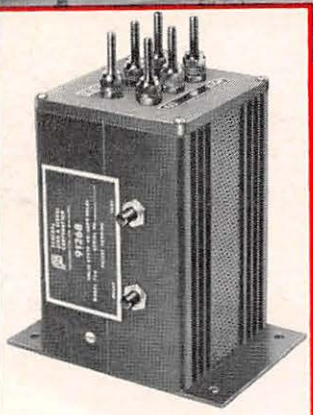

XR or XGPR

Ordering Ref.: 91268

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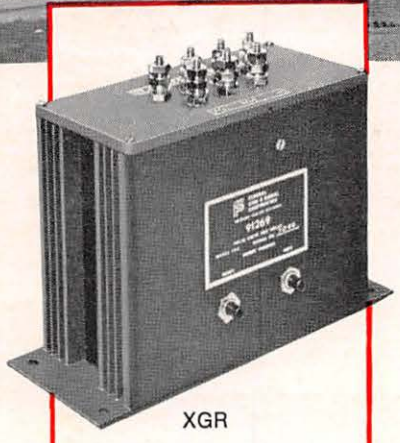

XGR

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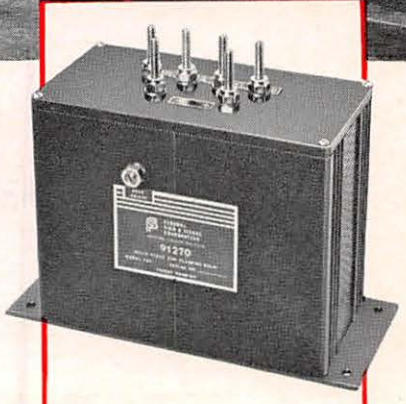

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